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Murakami

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(45) Date of Patent: Aug. 4, 2015

(54) **OPERATION MONITORING APPARATUS, CAUSE EVENT ESTIMATING METHOD FOR THE SAME, AND INFORMATION COMMUNICATION NETWORK SYSTEM**

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(73) Assignee: **FUJITSU LIMITED**, Kawasaki (JP)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 178 days.

(21) Appl. No.: **13/859,260**

(22) Filed: **Apr. 9, 2013**

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(30) **Foreign Application Priority Data**

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(51) **Int. Cl.**

H04J 1/16 (2006.01)
H04W 24/08 (2009.01)
H04L 12/24 (2006.01)

(52) **U.S. Cl.**

CPC ***H04W 24/08*** (2013.01); ***H04L 41/0631*** (2013.01)

(58) **Field of Classification Search**

USPC 370/241, 241.1, 252, 253, 332
See application file for complete search history.

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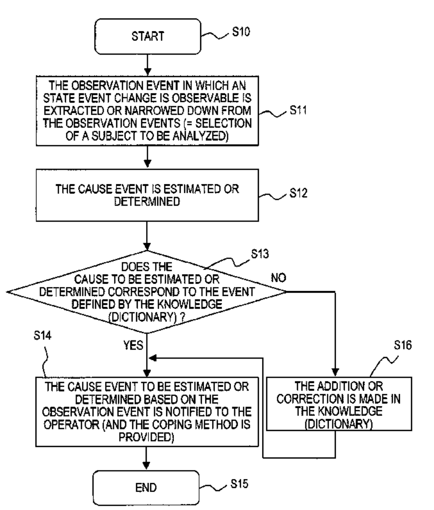
(74) *Attorney, Agent, or Firm* — Fujitsu Patent Center

(57) **ABSTRACT**

An operation monitoring apparatus for estimating a cause by which a first and second observation data observed by a monitored apparatus are obtained, the operation monitoring apparatus including: an observation event receiving process unit which receives the first and second observation data transmitted from the monitored apparatus; an observation event extracting unit which extracts the first observation data, out of the first and second observation data, based on a probability that the cause occurs with respect to the first and second observation data; a cause event determining process unit which estimates the cause based on the extracted first observation data; and a cause notifying process unit which outputs data indicating the estimated cause.

13 Claims, 32 Drawing Sheets



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Gao, C. et al, "Host Anomalies Detection Using Logistic Regression Modeling," 2009 First International Workshop on Education Technology and Computer Science, IEEE, Mar. 7, 2009, pp. 655-659, XP03145853.

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* cited by examiner

FIG. 1

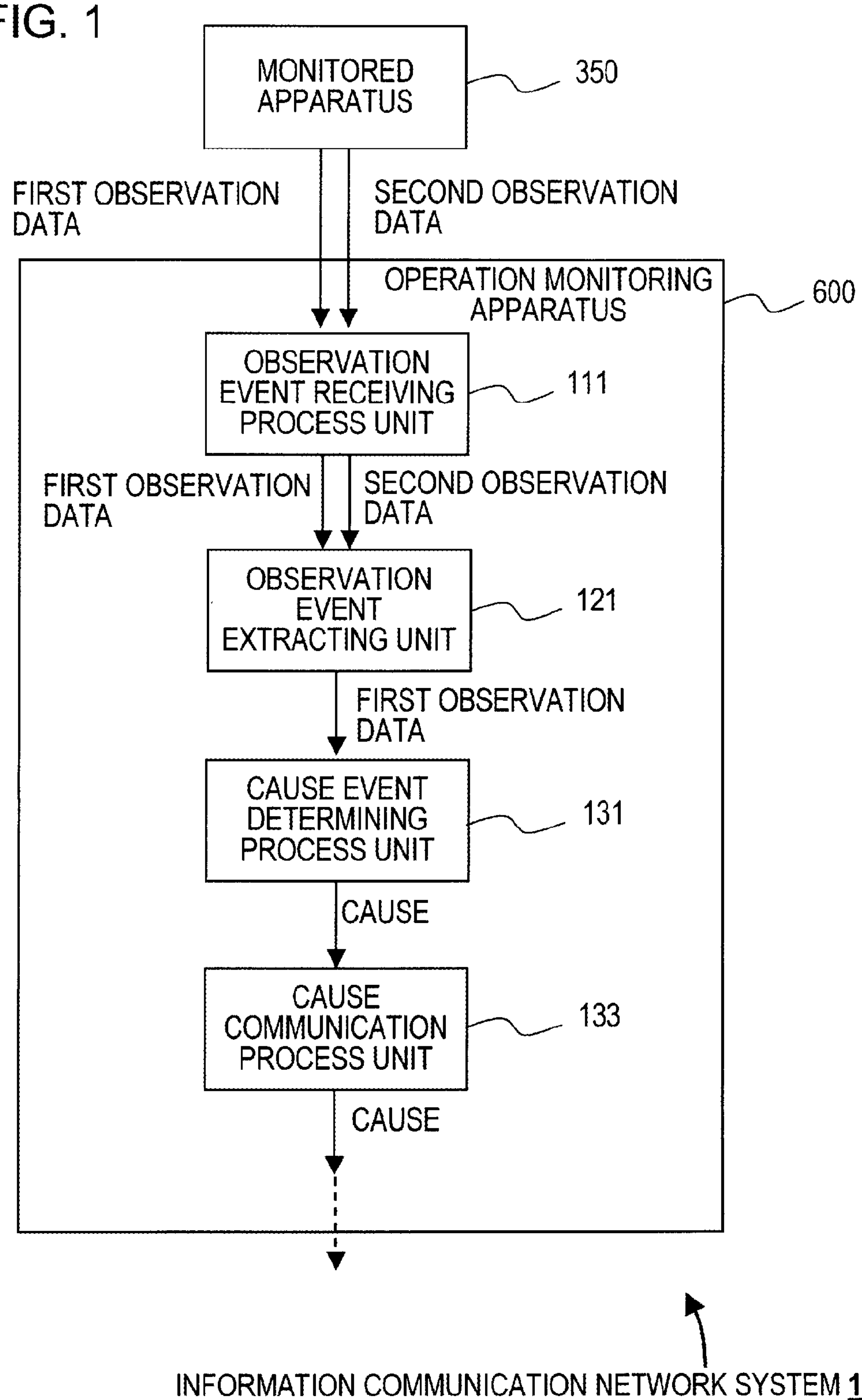

MONITORED APPARATUS
350
FIRST OBSERVATION DATA
SECOND OBSERVATION DATA
OPERATION MONITORING APPARATUS
600
OBSERVATION EVENT RECEIVING PROCESS UNIT
111
FIRST OBSERVATION DATA
SECOND OBSERVATION DATA
OBSERVATION EVENT EXTRACTING UNIT
121
FIRST OBSERVATION DATA
CAUSE EVENT DETERMINING PROCESS UNIT
131
CAUSE
CAUSE COMMUNICATION PROCESS UNIT
133
CAUSE
INFORMATION COMMUNICATION NETWORK SYSTEM 10

FIG. 2

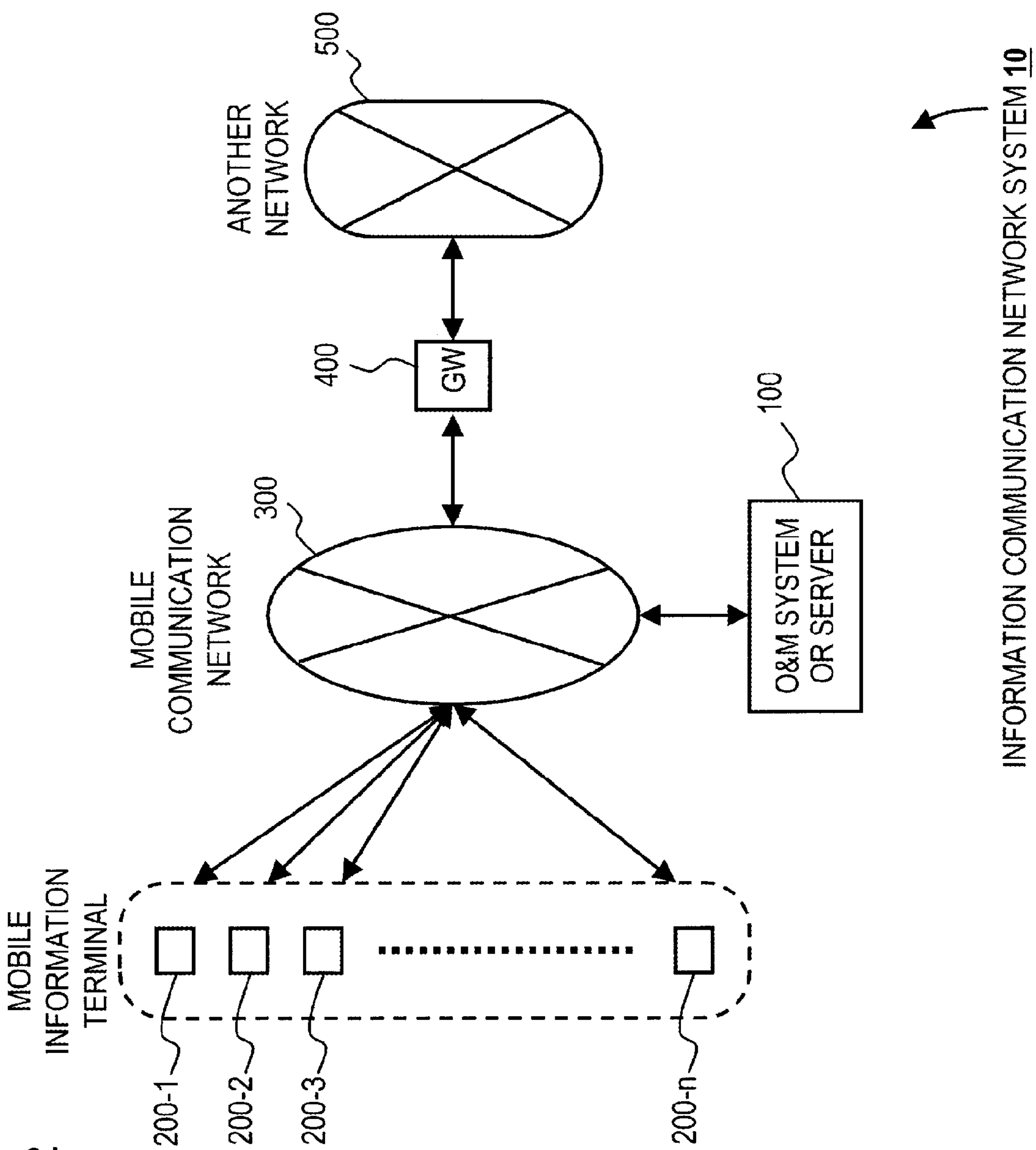

MOBILE INFORMATION TERMINAL
200-1
200-2
200-3
200-n
MOBILE COMMUNICATION NETWORK
300
GW
400
ANOTHER NETWORK
500
O&M SYSTEM OR SERVER
100
INFORMATION COMMUNICATION NETWORK SYSTEM 10

FIG. 3

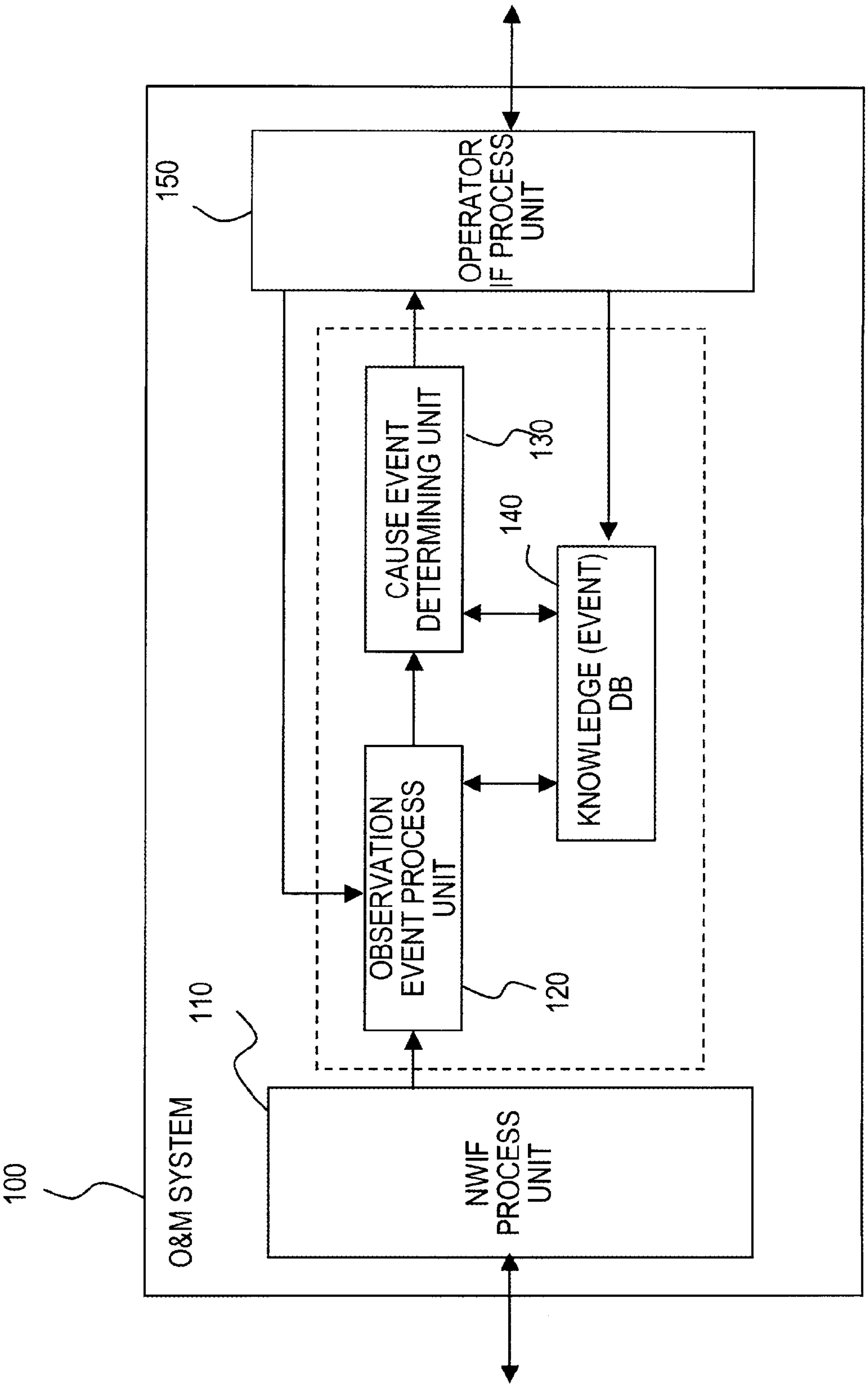
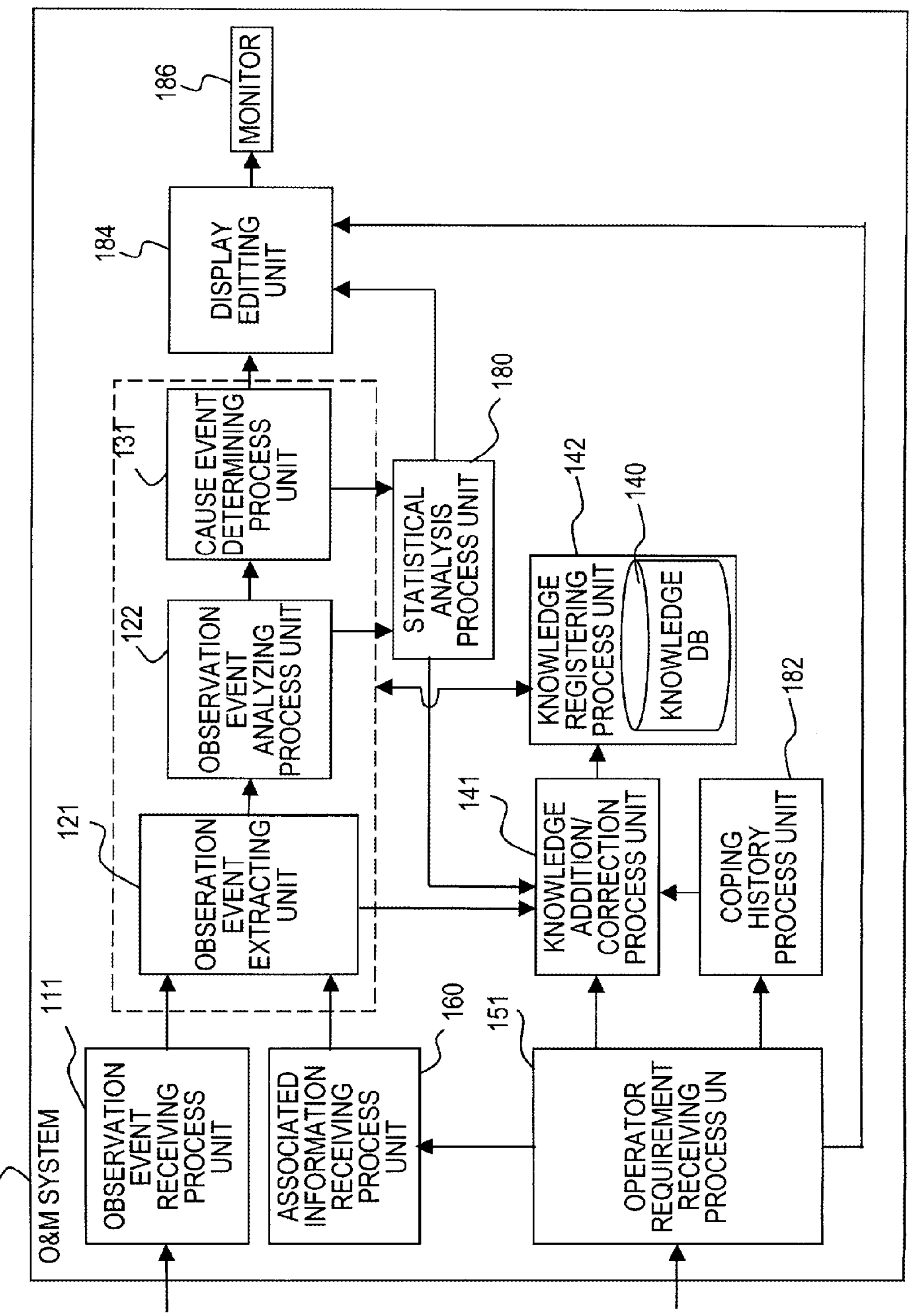

100
O&M SYSTEM
110
NWIF PROCESS UNIT
120
OBSERVATION EVENT PROCESS UNIT
130
CAUSE EVENT DETERMINING UNIT
140
KNOWLEDGE (EVENT) DB
150
OPERATOR IF PROCESS UNIT

FIG. 4



100
O&M SYSTEM
111
OBSERVATION EVENT RECEIVING PROCESS UNIT
160
ASSOCIATED INFORMATION RECEIVING PROCESS UNIT
151
OPERATOR REQUIREMENT RECEIVING PROCESS UN
121
OBSERVATION EVENT EXTRACTING UNIT
122
OBSERVATION EVENT ANALYZING PROCESS UNIT
131
CAUSE EVENT DETERMINING PROCESS UNIT
180
STATISTICAL ANALYSIS PROCESS UNIT
141
KNOWLEDGE ADDITION/ CORRECTION PROCESS UNIT
142
KNOWLEDGE REGISTERING PROCESS UNIT
140
KNOWLEDGE DB
182
COPING HISTORY PROCESS UNIT
184
DISPLAY EDITTING UNIT
186
MONITOR

FIG. 5

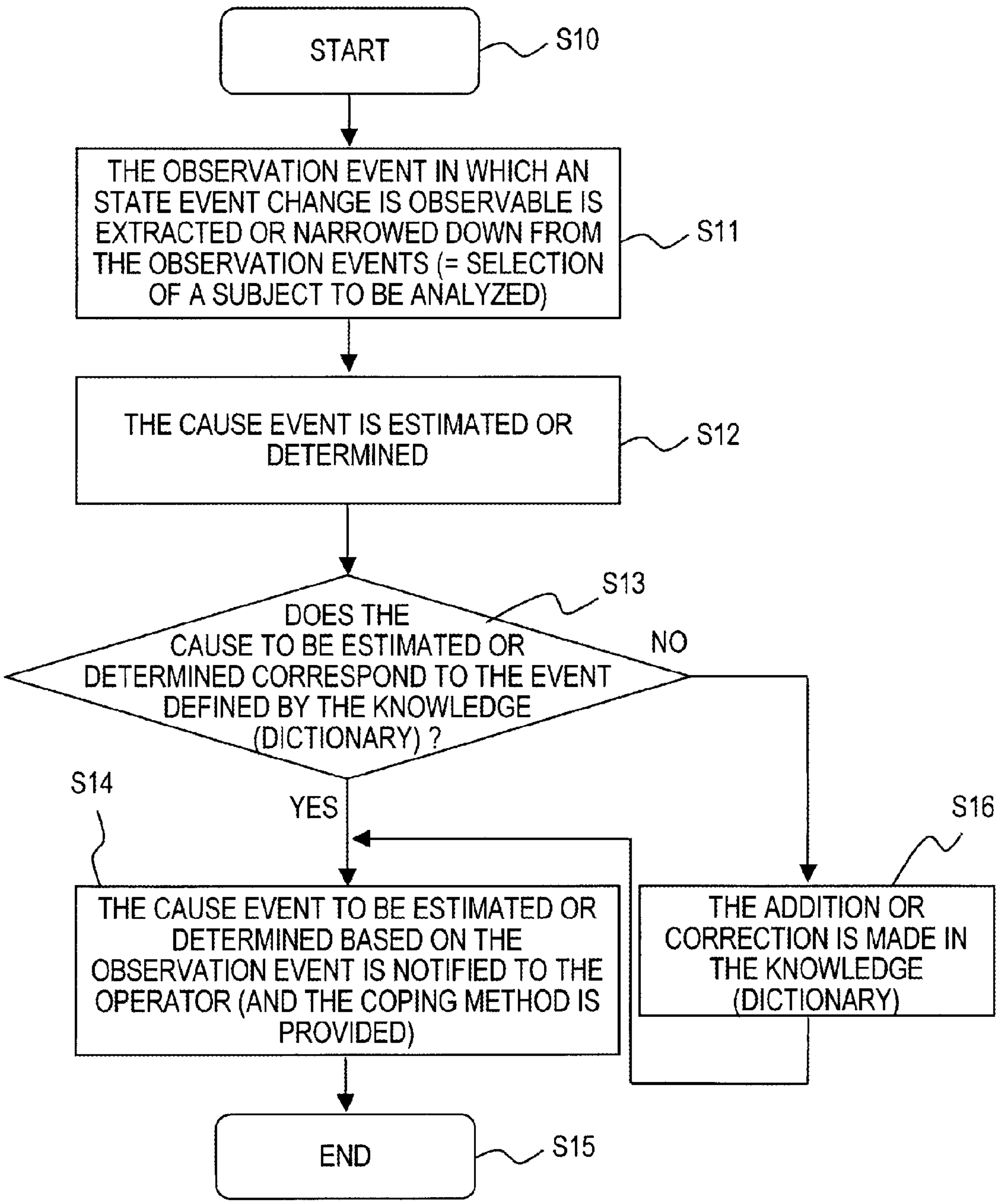

START
S10
THE OBSERVATION EVENT IN WHICH AN STATE EVENT CHANGE IS OBSERVABLE IS EXTRACTED OR NARROWED DOWN FROM THE OBSERVATION EVENTS (= SELECTION OF A SUBJECT TO BE ANALYZED)
S11
THE CAUSE EVENT IS ESTIMATED OR DETERMINED
S12
S13
DOES THE CAUSE TO BE ESTIMATED OR DETERMINED CORRESPOND TO THE EVENT DEFINED BY THE KNOWLEDGE (DICTIONARY) ?
NO
YES
S14
S16
THE CAUSE EVENT TO BE ESTIMATED OR DETERMINED BASED ON THE OBSERVATION EVENT IS NOTIFIED TO THE OPERATOR (AND THE COPING METHOD IS PROVIDED)
THE ADDITION OR CORRECTION IS MADE IN THE KNOWLEDGE (DICTIONARY)
END
S15

FIG. 6

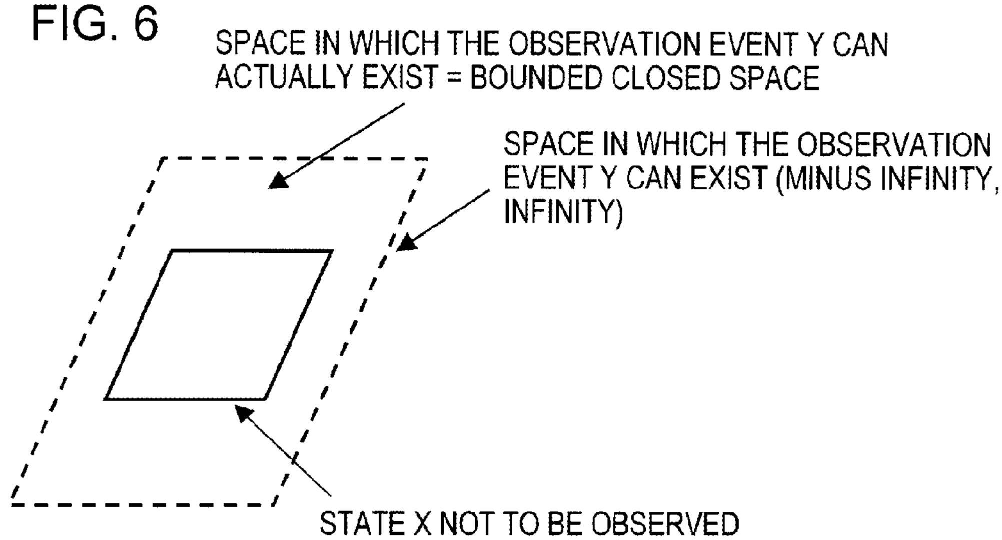

SPACE IN WHICH THE OBSERVATION EVENT Y CAN ACTUALLY EXIST = BOUNDED CLOSED SPACE
SPACE IN WHICH THE OBSERVATION EVENT Y CAN EXIST (MINUS INFINITY, INFINITY)
STATE X NOT TO BE OBSERVED

FIG. 7

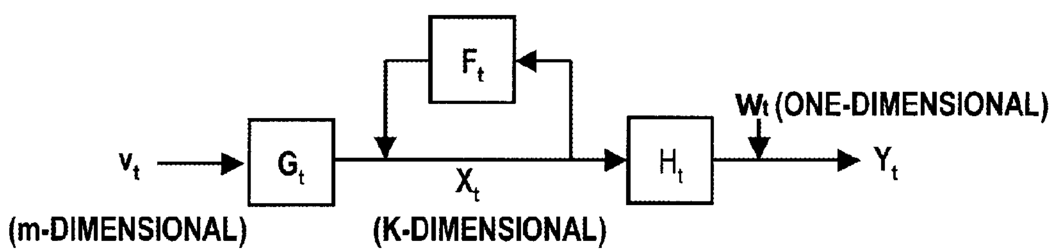

F_t
v_t
G_t
X_t
H_t
W_t (ONE-DIMENSIONAL)
Y_t
(m-DIMENSIONAL)
(K-DIMENSIONAL)

FIG. 8

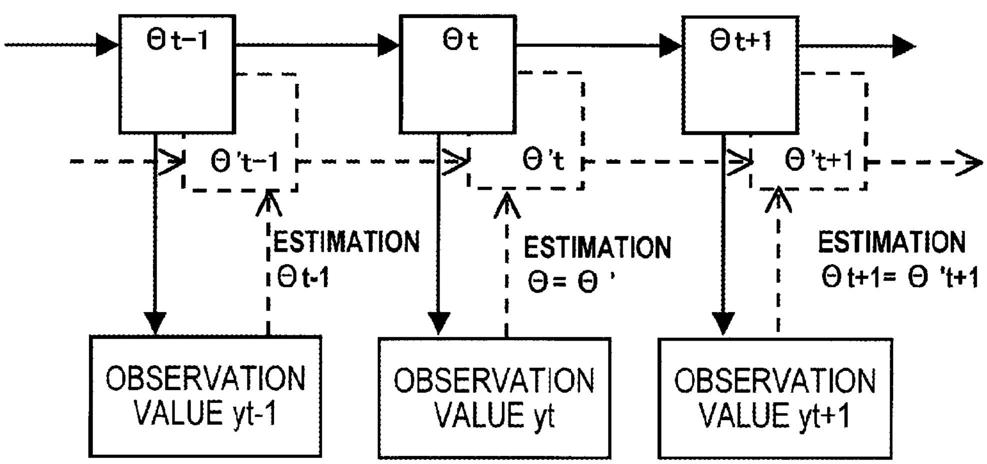

Θt−1
Θt
Θt+1
Θ't−1
Θ't
Θ't+1
ESTIMATION
Θt-1
ESTIMATION
Θ= Θ '
ESTIMATION
Θt+1= Θ 't+1
OBSERVATION VALUE yt-1
OBSERVATION VALUE yt
OBSERVATION VALUE yt+1

FIG. 9A

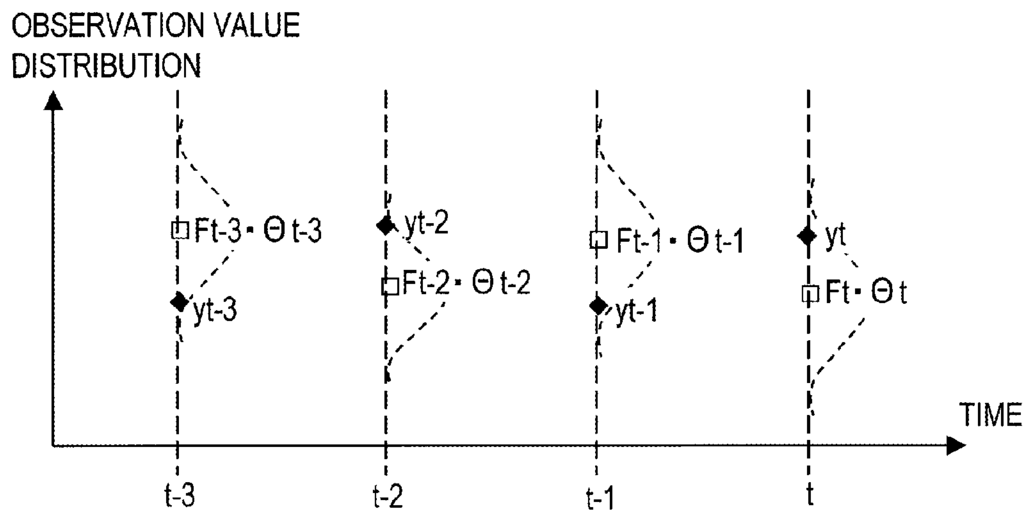

OBSERVATION VALUE
DISTRIBUTION
Ft-3・Θt-3
yt-3
yt-2
Ft-2・Θt-2
Ft-1・Θt-1
yt-1
yt
Ft・Θt
TIME
t-3
t-2
t-1
t

FIG. 9B

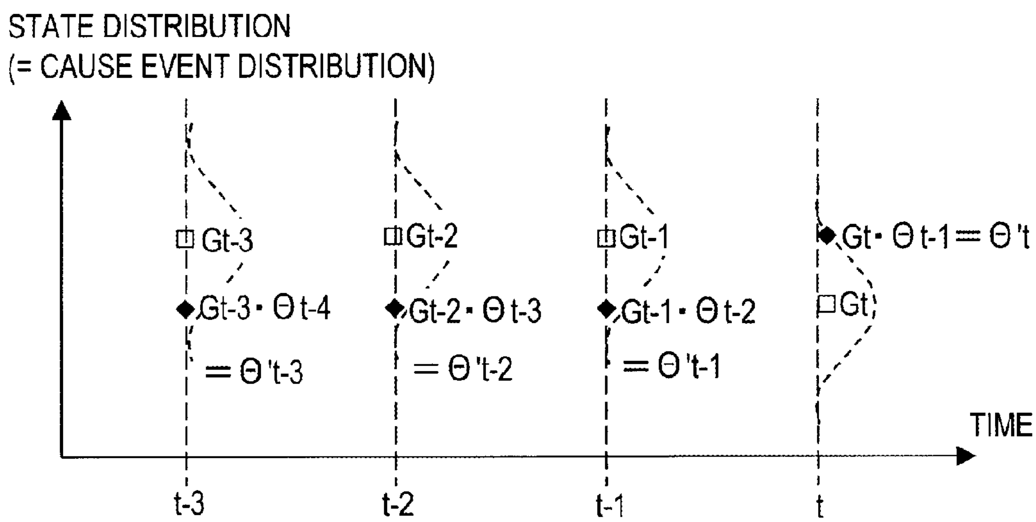

STATE DISTRIBUTION
(= CAUSE EVENT DISTRIBUTION)
Gt-3
Gt-3・Θt-4
= Θ't-3
Gt-2
Gt-2・Θt-3
= Θ't-2
Gt-1
Gt-1・Θt-2
= Θ't-1
Gt・Θt-1 = Θ't
Gt
TIME
t-3
t-2
t-1
t

FIG. 10

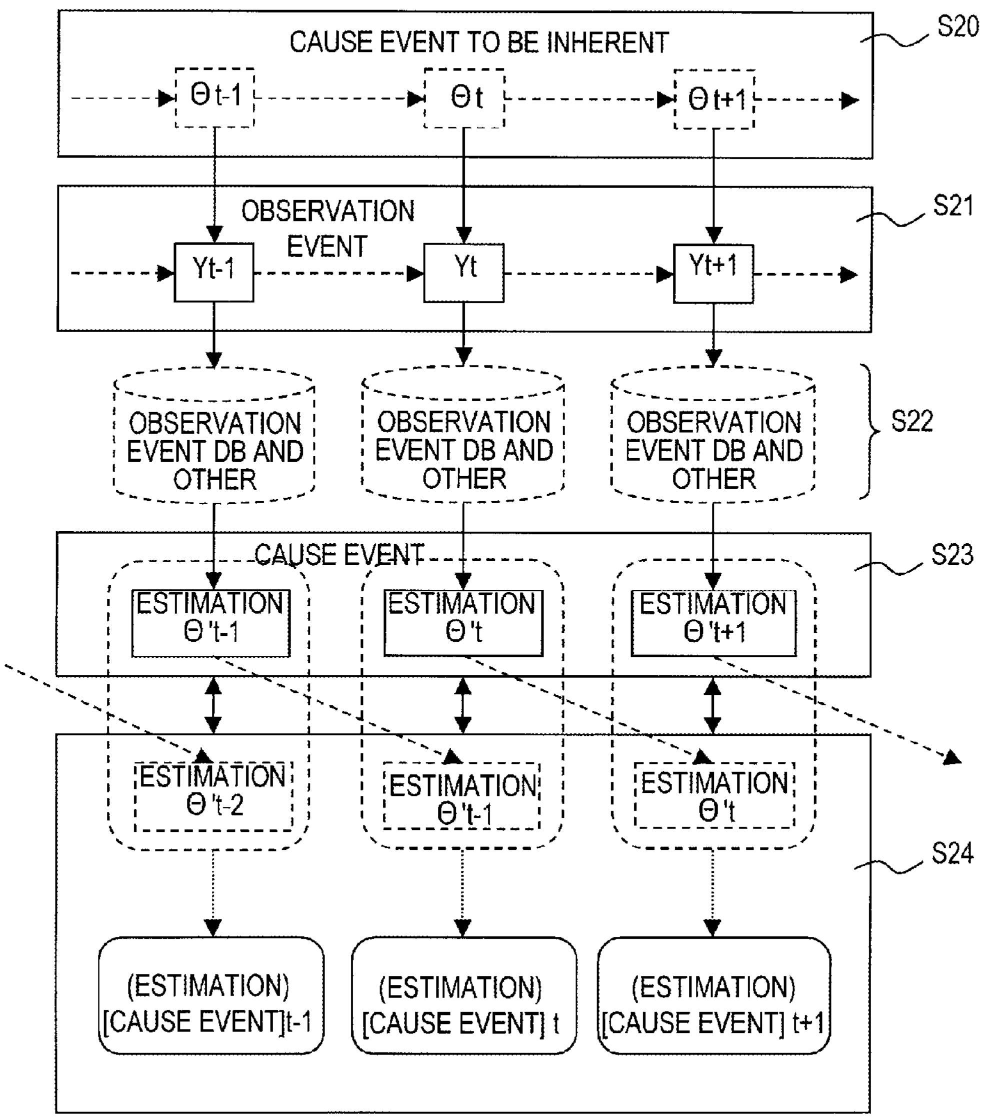

CAUSE EVENT TO BE INHERENT
Θt-1
Θt
Θt+1
S20
OBSERVATION EVENT
Yt-1
Yt
Yt+1
S21
OBSERVATION EVENT DB AND OTHER
OBSERVATION EVENT DB AND OTHER
OBSERVATION EVENT DB AND OTHER
S22
CAUSE EVENT
ESTIMATION Θ't-1
ESTIMATION Θ't
ESTIMATION Θ't+1
S23
ESTIMATION Θ't-2
ESTIMATION Θ't-1
ESTIMATION Θ't
S24
(ESTIMATION) [CAUSE EVENT]t-1
(ESTIMATION) [CAUSE EVENT] t
(ESTIMATION) [CAUSE EVENT] t+1

FIG. 11

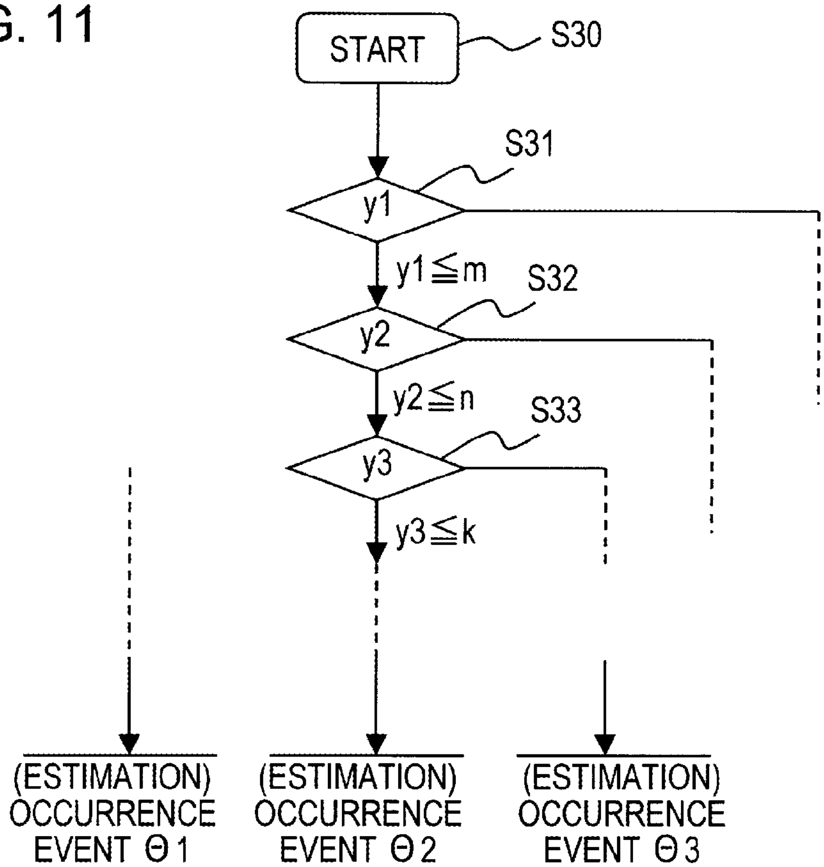
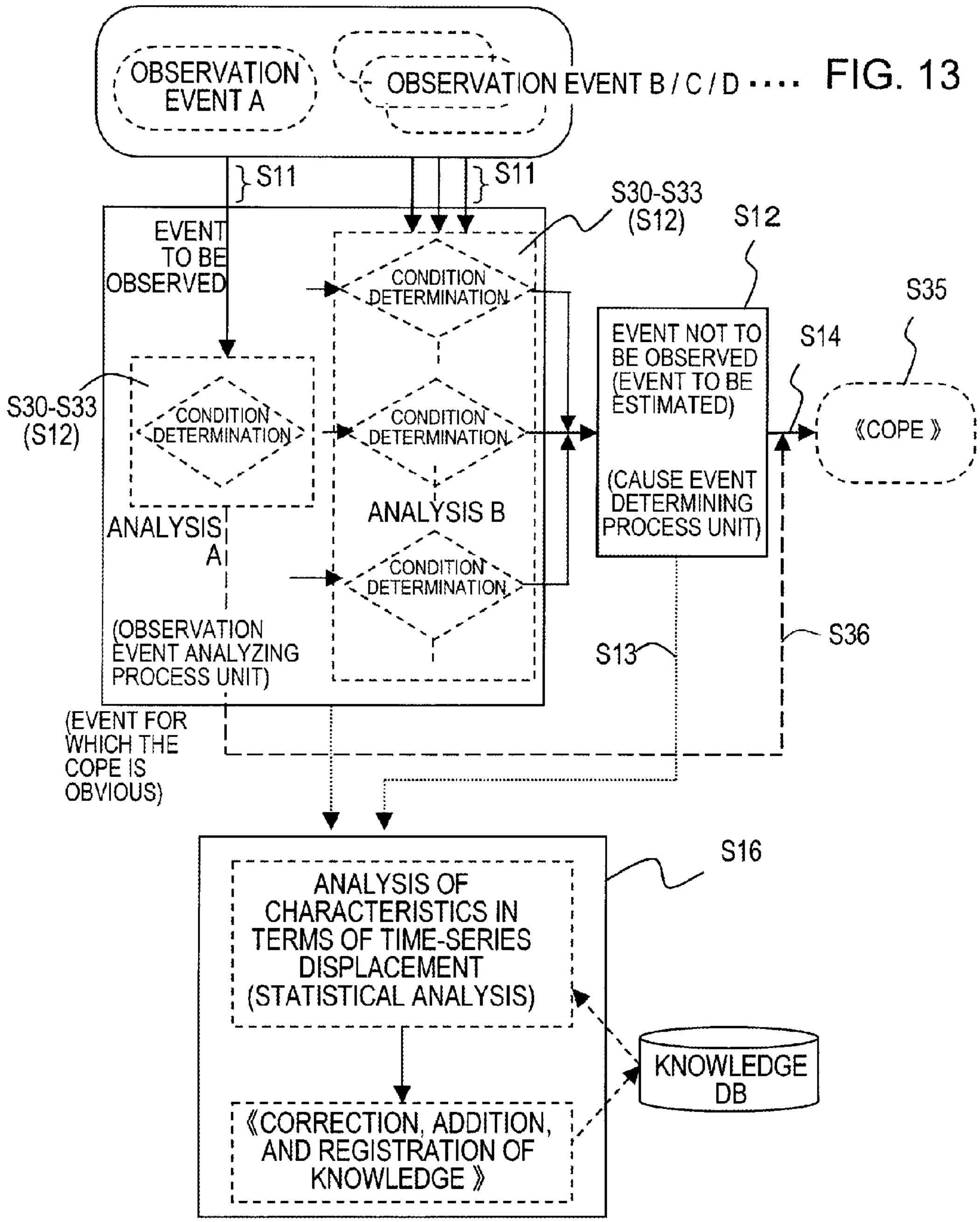


FIG. 12

SELF CELL TRAFFIC	HIGH
ANOTHER CELL TRAFFIC	LOW
CALL DROP	LOW
ANOTHER CELL RL-F	HIGH

FIG. 13



OBSERVATION EVENT A
OBSERVATION EVENT B / C / D ····
S11
S11
S30-S33 (S12)
S12
EVENT TO BE OBSERVED
CONDITION DETERMINATION
S30-S33 (S12)
CONDITION DETERMINATION
CONDITION DETERMINATION
ANALYSIS A
ANALYSIS B
CONDITION DETERMINATION
(OBSERVATION EVENT ANALYZING PROCESS UNIT)
EVENT NOT TO BE OBSERVED (EVENT TO BE ESTIMATED)
(CAUSE EVENT DETERMINING PROCESS UNIT)
S14
S35
《COPE》
S13
S36
(EVENT FOR WHICH THE COPE IS OBVIOUS)
S16
ANALYSIS OF CHARACTERISTICS IN TERMS OF TIME-SERIES DISPLACEMENT (STATISTICAL ANALYSIS)
《CORRECTION, ADDITION, AND REGISTRATION OF KNOWLEDGE》
KNOWLEDGE DB

FIG. 14

CLASSIFICATION	APPARATUSES TO BE OBSERVED, LOCATIONS, AND SO ON		EVENT TO BE OBSERVED
QUALITY STATES	RNC/ CELL/ SECTOR/ SPECIFIC LOCATION/ SPECIFIC TIME	UP LINK	TX LEVEL INCREASE
			RX LEVEL REDUCTION
			BLER INCREASE
			SIR INCREASE
			Ec/Io INCREASE
		DOWN LINK	TX LEVEL INCREASE
			RX LEVEL REDUCTION
			BLER INCREASE
			SIR INCREASE
			Ec/Io INCREASE
CALL CONNECTION STATES	RNC/ CELL/ SECTOR/ SPECIFIC LOCATION/ SPECIFIC TIME	AMR	LOCATION REGISTRATION IS NOT POSSIBLE
			CALL CONNECTION IS NOT POSSIBLE
			ONE-WAY CALLING
			SOUNDLESS
			NOISE IS SUBSTANTIALLY NOTICEABLE
			OCCURRENCE OF CALL DISCONNECTION
			INCOMING CALL IS NOT AVAILABLE
		PS	ATTACH IS NOT POSSIBLE
			CALL CONNECTION IS NOT POSSIBLE
			THROUGHPUT IS REDUCED
			OCCURRENCE OF CALL DISCONNECTION
		:	:
		:	:

FIG. 15

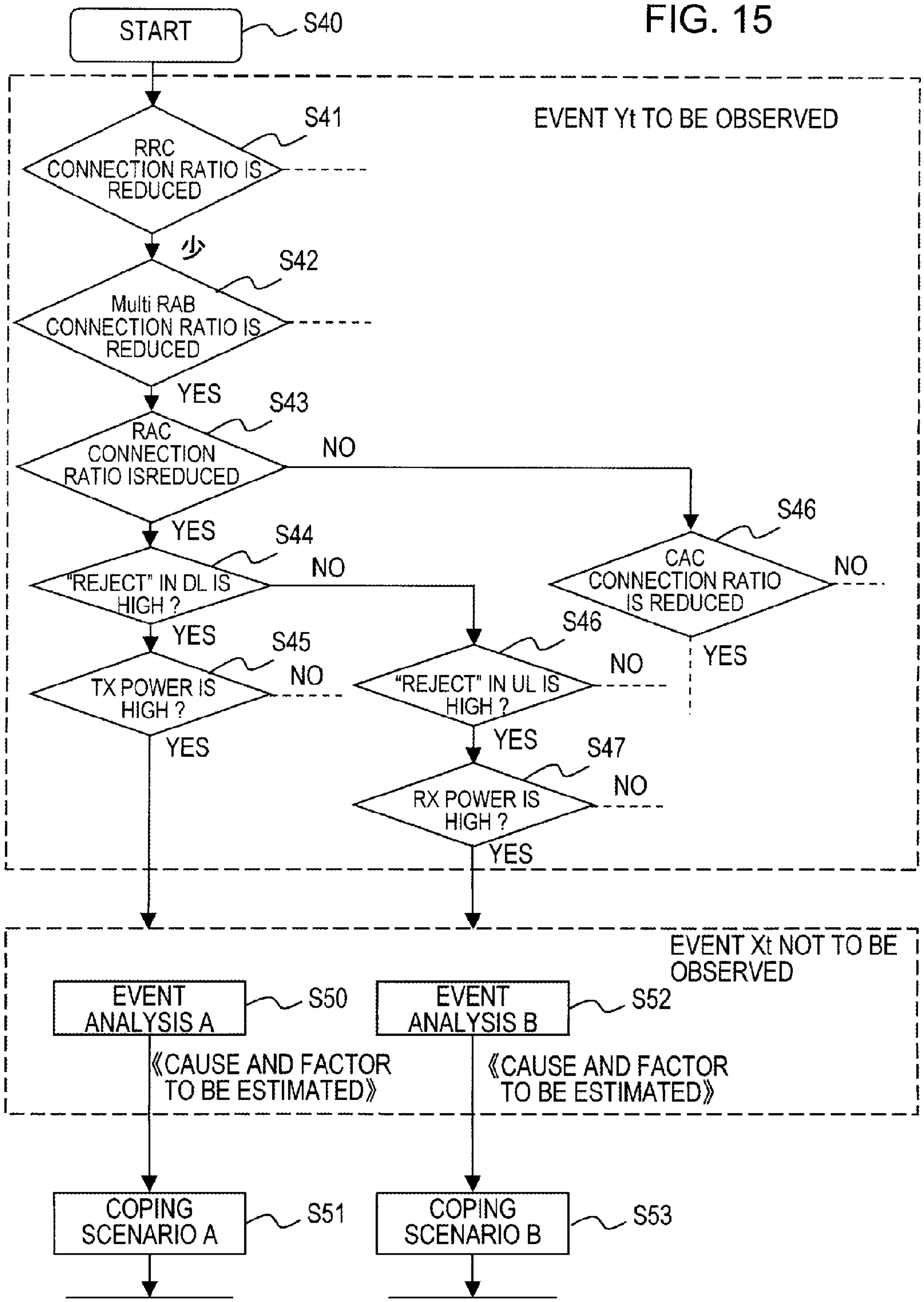

START
S40
EVENT Yt TO BE OBSERVED
S41
RRC CONNECTION RATIO IS REDUCED
少
S42
Multi RAB CONNECTION RATIO IS REDUCED
YES
S43
RAC CONNECTION RATIO ISREDUCED
NO
YES
S44
"REJECT" IN DL IS HIGH ?
NO
S46
CAC CONNECTION RATIO IS REDUCED
NO
YES
YES
S45
TX POWER IS HIGH ?
NO
YES
S46
"REJECT" IN UL IS HIGH ?
NO
YES
S47
RX POWER IS HIGH ?
NO
YES
EVENT Xt NOT TO BE OBSERVED
EVENT ANALYSIS A
S50
EVENT ANALYSIS B
S52
《CAUSE AND FACTOR TO BE ESTIMATED》
《CAUSE AND FACTOR TO BE ESTIMATED》
COPING SCENARIO A
S51
COPING SCENARIO B
S53

FIG. 16

THE CONNECTION SUCCESS RATIO OF RRC connection phase (THE TOTAL OF SENDING AND RECEIVING CALLS REGARDING THE ENTIRE TYPES) IS REDUCED
THE CONNECTION SUCCESS RATIO OF RAB establishment phase (THE TOTAL OF ENTIRE RAB) IS REDUCED
THE CONNECTION SUCCESS RATIO OF multi RAB (2ND RAB ONWARD) IS REDUCED
RRC connection reject RATIO (THE TOTAL OF SENDING AND RECEIVING CALLS REGARDING THE ENTIRE TYPES) IS HIGH
RRC connection setup TRANSMISSION RATIO (THE TOTAL OF SENDING AND RECEIVING CALLS REGARDING THE ENTIRE TYPES) IS LOW
RRC connection setup COMPLETE RATIO (THE TOTAL OF SENDING AND RECEIVING CALLS REGARDING THE ENTIRE TYPES) IS LOW
THE CONNECTION SUCCESS RATIO OF RAB establishment phase REGARDING CS TOTAL IS LOW
THE CONNECTION SUCCESS RATIO OF RAB establishment phase REGARDING PS TOTAL IS LOW
:
:
THE CONNECTION SUCCESS RATIO OF RRC connection phase (THE TOTAL OF SENDING AND RECEIVING CALLS REGARDING conversational) IS LOW
THE CONNECTION SUCCESS RATIO OF RRC connection phase (THE TOTAL OF SENDING AND RECEIVING CALLS REGARDING streaming) IS LOW
:
:
THE RAB CONNECTION FAILURE RATIO ACCORDING TO Radio Link reconfiguration failure with cause UR (AMR) IS HIGH
THE RAB CONNECTION FAILURE RATIO ACCORDING TO Radio Link reconfiguration failure with cause DL (AMR) IS HIGH
:
:
THE FAILURE RATIO OF RAB reject with cause of unspecific (CS) IS HIGH
THE FAILURE RATIO OF RAB reject with cause of resource (CS) IS HIGH
:

FIG. 17

CLASSIFICATION	CAUSAL APPARATUSES AND LOCATIONS	CAUSAL EVENTS
QUALITY AND CALL CONNECTION STATES	RNC/ CELL/ Sector/ SPECIFIC LOCATION/ SPECIFIC TIME	LOADS HAVE CONCENTRATED
		THE NUMBER OF Attempts IS LARGE
		INTERFERENCE WAVES ARE NOTICEABLE
		THERE IS AN ERROR IN THE SETTING PARAMETERS
		TRANSMISSION POWER IS INSUFFICIENT
		RADIO RESOURCE IS INSUFFICIENT
		COVERAGE HOLE OCCURS
		:
		:
		:
HANDOVER	H/O TYPE (HARD/ SOFT ····)	1a (1b) THRESHOLD VALUE IS TOO LOW OR TOO HIGH
		THE NUMBER OF ACTIVE SETS IS TOO MANY
		SECTOR IS UNREGISTERED IN NEVER-LIST
		CELL IS UNREGISTERED IN NEVER-LIST
		FREQUENCY IS UNREGISTERED IN NEVER-LIST
		:
		:

FIG. 18

SELF CELL TRAFFIC	HIGH	HIGH	HIGH	HIGH	LOW	LOW	LOW	LOW	HIGH	HIGH	HIGH	...	...
ANOTHER CELL TRAFFIC	HIGH	LOW	HIGH	LOW	HIGH	LOW	HIGH	LOW	HIGH	LOW	HIGH	...	...
Call Drop	LOW	LOW	HIGH	HIGH	LOW	LOW	HIGH	HIGH	LOW	LOW	HIGH	...	...
ANOTHER CELL RL-F	HIGH	HIGH	HIGH	HIGH	HIGH	HIGH	HIGH	HIGH	LOW	LOW	LOW	...	...
ANALYSIS RESULT NO.	11	13	12	14	15	15	16	16	11	13	12	...	...

FIG. 19A

CONDITION	(1)	(2)	(3)	(4)	(5)	(6)
A: SELF CELL TRAFFIC	HIGH	HIGH	HIGH	LOW	LOW	LOW
B: ANOTHER CELL TRAFFIC	HIGH	MEDIUM	LOW	HIGH	MEDIUM	LOW
C: HO RATIO	HIGH	HIGH	HIGH	HIGH	HIGH	HIGH

FIG. 19B

CONDITION	(7)	(8)	(9)	(10)	(11)	(12)
A: SELF CELL TRAFFIC	HIGH	HIGH	HIGH	LOW	LOW	LOW
B: ANOTHER CELL TRAFFIC	HIGH	MEDIUM	LOW	HIGH	MEDIUM	LOW
C: HO RATIO	LOW	LOW	LOW	LOW	LOW	LOW

FIG. 20

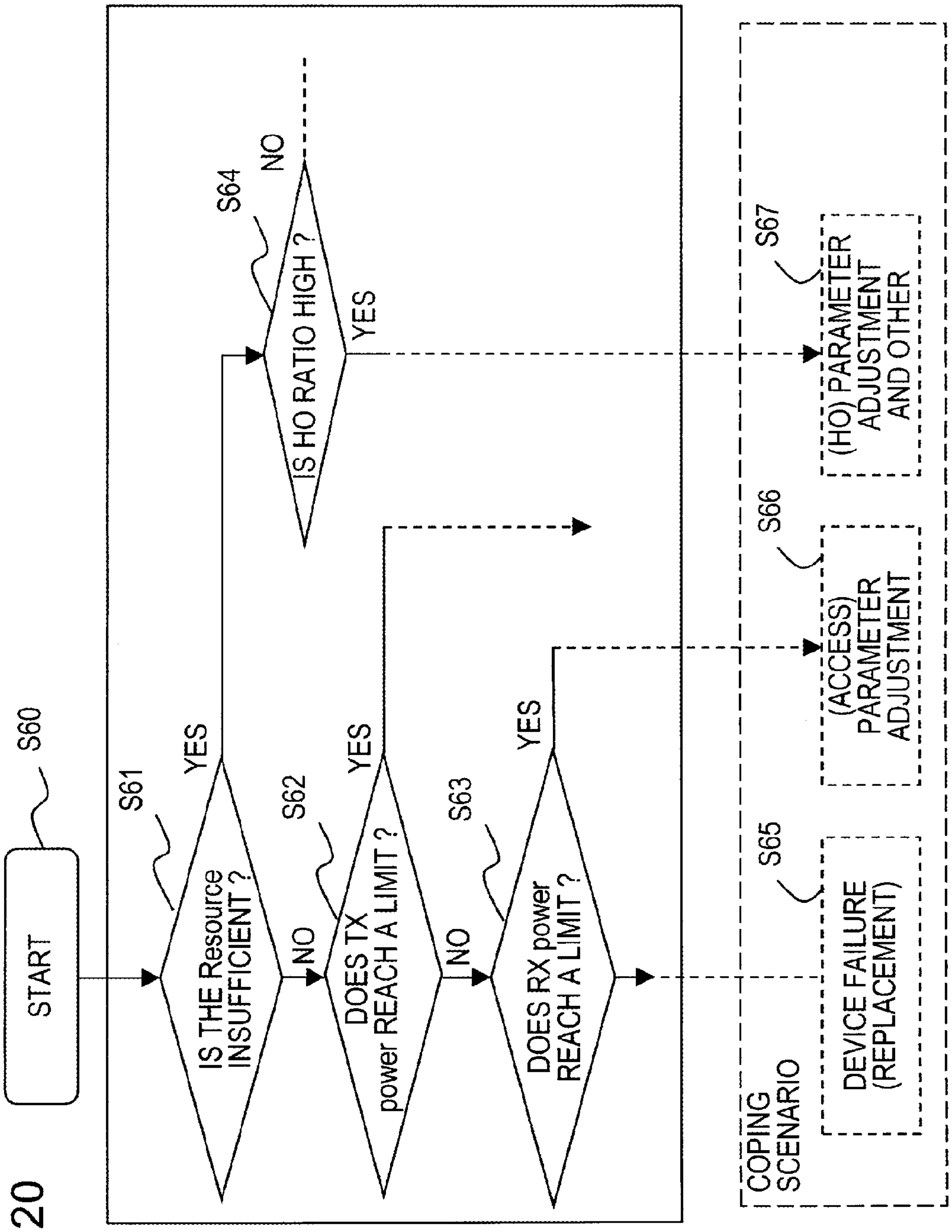
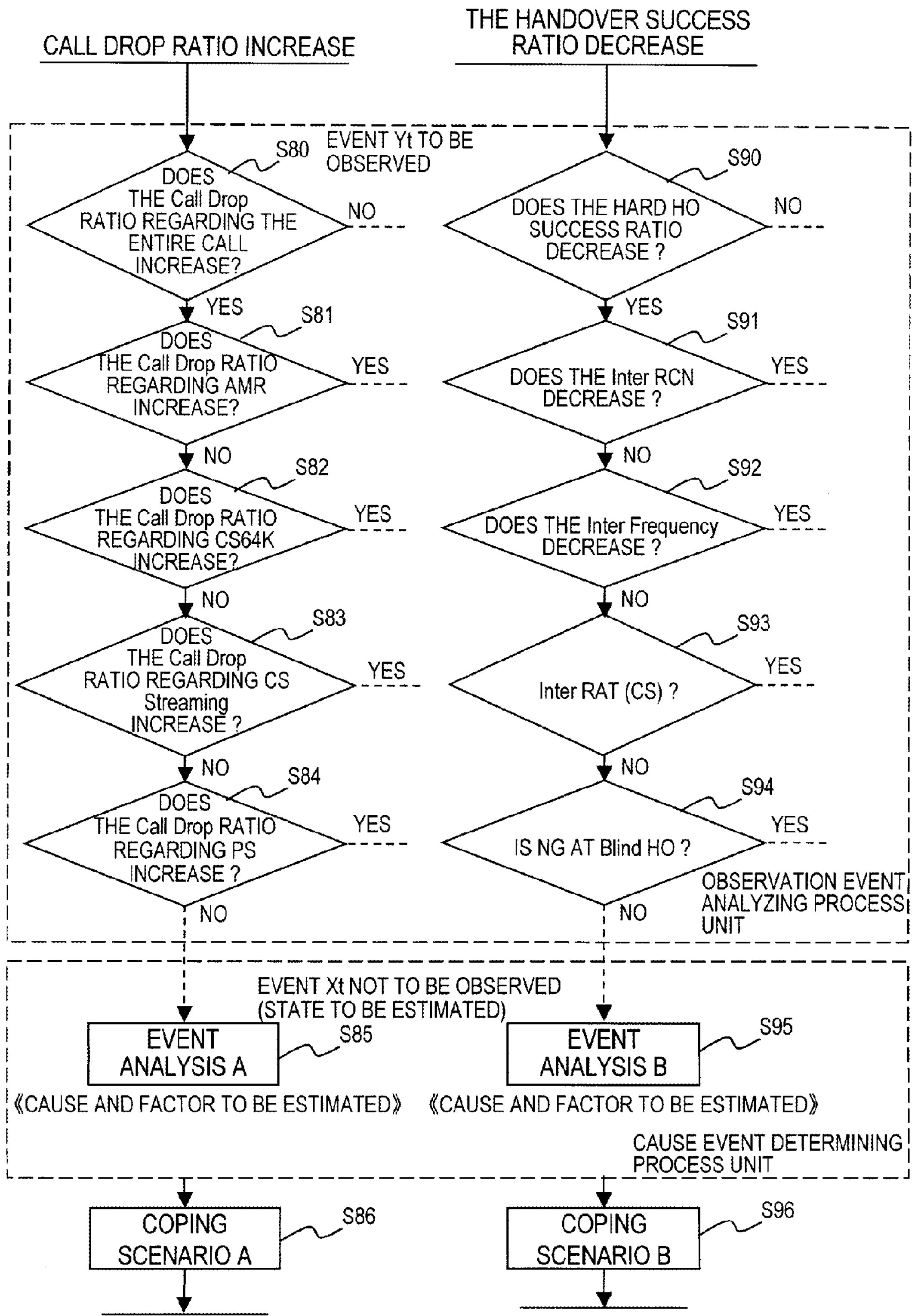

START
S60
IS THE Resource INSUFFICIENT ?
S61
YES
NO
DOES TX power REACH A LIMIT ?
S62
YES
NO
DOES RX power REACH A LIMIT ?
S63
YES
IS HO RATIO HIGH ?
S64
YES
NO
COPING SCENARIO
DEVICE FAILURE (REPLACEMENT)
S65
(ACCESS) PARAMETER ADJUSTMENT
S66
(HO) PARAMETER ADJUSTMENT AND OTHER
S67

FIG. 21

OBSERVATION EVENT (DATA)	SELF CELL TRAFFIC = HIGH ANOTHER CELL TRAFFIC = HIGH Call Drop RATIO = LOW	SELF CELL TRAFFIC = HIGH ANOTHER CELL TRAFFIC = HIGH Call Drop RATIO = HIGH
EVENT OBTAINED BASED ON OBSERVATION	LOADS IN SELF AND ANOTHER CELL ARE LARGE, WHICH FAILS TO SATISFY THE QUALITY REQUIREMENTS ON UL SIDE, AND "REJECT" OCCURS	
EVENT TO BE ESTIMATED OR DETERMINED	ERROR IN PARAMETER SETTINGS/ HO AREA IS TOO WIDE/ EXCESSIVE RADIO WAVES ARE RECEIVED FROM ANOTHER CELL/ TX SYSTEM APPARATUS FAILURE/ OVERLOAD/ OTHER	ERROR IN PARAMETER SETTINGS/ HO AREA IS TOO WIDE/ EXCESSIVE RADIO WAVES ARE RECEIVED FROM ANOTHER CELL/ TX SYSTEM APPARATUS FAILURE/ OVERLOAD/ OTHER
MEASURES AND COPE OF THE OPERATOR (THE ITEM NUMBER IN THE TABLE INDICATES THE ORDER OF COPE)	1. Admission THRESHOLD VALUE IS RAISED 2. CORRECTION OF CHCH Power DISTRIBUTION 3. RF EXTENSION 4. CHANGE OF TILTING ANTENNAS OF OTHER BASE STATION 5. SECTOR EXTENSION 6. BASE STATION EXTENSION 6. FIELD SURVEY (DRIVE TEST IN THE VICINITY OF CELL EDGE)	1. CORRECTION OF CHCH Power DISTRIBUTION 2. RF EXTENSION 3. SELF CELL CESSATION (LOAD ALLEVIATION) 4. SECTOR EXTENSION 5. BASE STATION EXTENSION 6. FIELD SURVEY (DRIVE TEST IN THE VICINITY OF CELL EDGE)

FIG. 22



CALL DROP RATIO INCREASE
THE HANDOVER SUCCESS RATIO DECREASE
EVENT Yt TO BE OBSERVED
S80
DOES THE Call Drop RATIO REGARDING THE ENTIRE CALL INCREASE?
NO
YES
S81
DOES THE Call Drop RATIO REGARDING AMR INCREASE?
YES
NO
S82
DOES THE Call Drop RATIO REGARDING CS64K INCREASE?
YES
NO
S83
DOES THE Call Drop RATIO REGARDING CS Streaming INCREASE ?
YES
NO
S84
DOES THE Call Drop RATIO REGARDING PS INCREASE ?
YES
NO
S90
DOES THE HARD HO SUCCESS RATIO DECREASE ?
NO
YES
S91
DOES THE Inter RCN DECREASE ?
YES
NO
S92
DOES THE Inter Frequency DECREASE ?
YES
NO
S93
Inter RAT (CS) ?
YES
NO
S94
IS NG AT Blind HO ?
YES
NO
OBSERVATION EVENT ANALYZING PROCESS UNIT
EVENT Xt NOT TO BE OBSERVED (STATE TO BE ESTIMATED)
EVENT ANALYSIS A
S85
EVENT ANALYSIS B
S95
《CAUSE AND FACTOR TO BE ESTIMATED》
《CAUSE AND FACTOR TO BE ESTIMATED》
CAUSE EVENT DETERMINING PROCESS UNIT
COPING SCENARIO A
S86
COPING SCENARIO B
S96

FIG. 23

Call Drop RATIO INCREASE	THE TOTAL call drop RATIO OF ALL SERVICES INCREASES
	THE TOTAL call drop RATIO OF CS INCREASES
	THE TOTAL call drop RATIO OF PS INCREASES
	THE call drop radio link failure OF CS INCREASES
	THE call drop radio link failure OF PS INCREASES (DCH)
	THE call drop radio link failure OF PS INCREASES (FACH)
	THE call drop radio link failure OF CS streaming INCREASES
	:
	:
	THE drop OCCURS WITHOUT DEPENDING ON SERVICES
	DOES IT OCCUR AT S SPECIFIC RATE ?
	DOES IT OCCUR IN A SPECIFIC CELL ?
	DOES IT OCCUR CONSECUTIVELY ?
	DOES IT OCCUR IN A SPECIFIC UE ?
	:
	:
HANDOVER SUCCESS RATIO DECREASES	THE SUCCESS RATIO AT preparation phase OF HHO IS REDUCED
	THE SUCCESS RATIO AT execution phase OF HHO IS REDUCED
	THE SUCCESS RATIO OF inter frequency HHO (blind HO) IS REDUCED (THE TOTAL OF ALL SERVICES)
	THE SUCCESS RATIO OF inter frequency HHO (blind HO) IS REDUCED (CS streaming)
	:
	:
	THE SUCCESS RATIO OF radio HO TO GSM (event 3a) AT execution phase OF inter RAT HHO IS REDUCED (THE TOTAL OF ALL SERVICES)
	THE SUCCESS RATIO OF blind HO TO GSM (event 2d_em) AT execution phase OF inter RAT HHO IS REDUCED (CS streaming)
	:
	:

FIG. 24

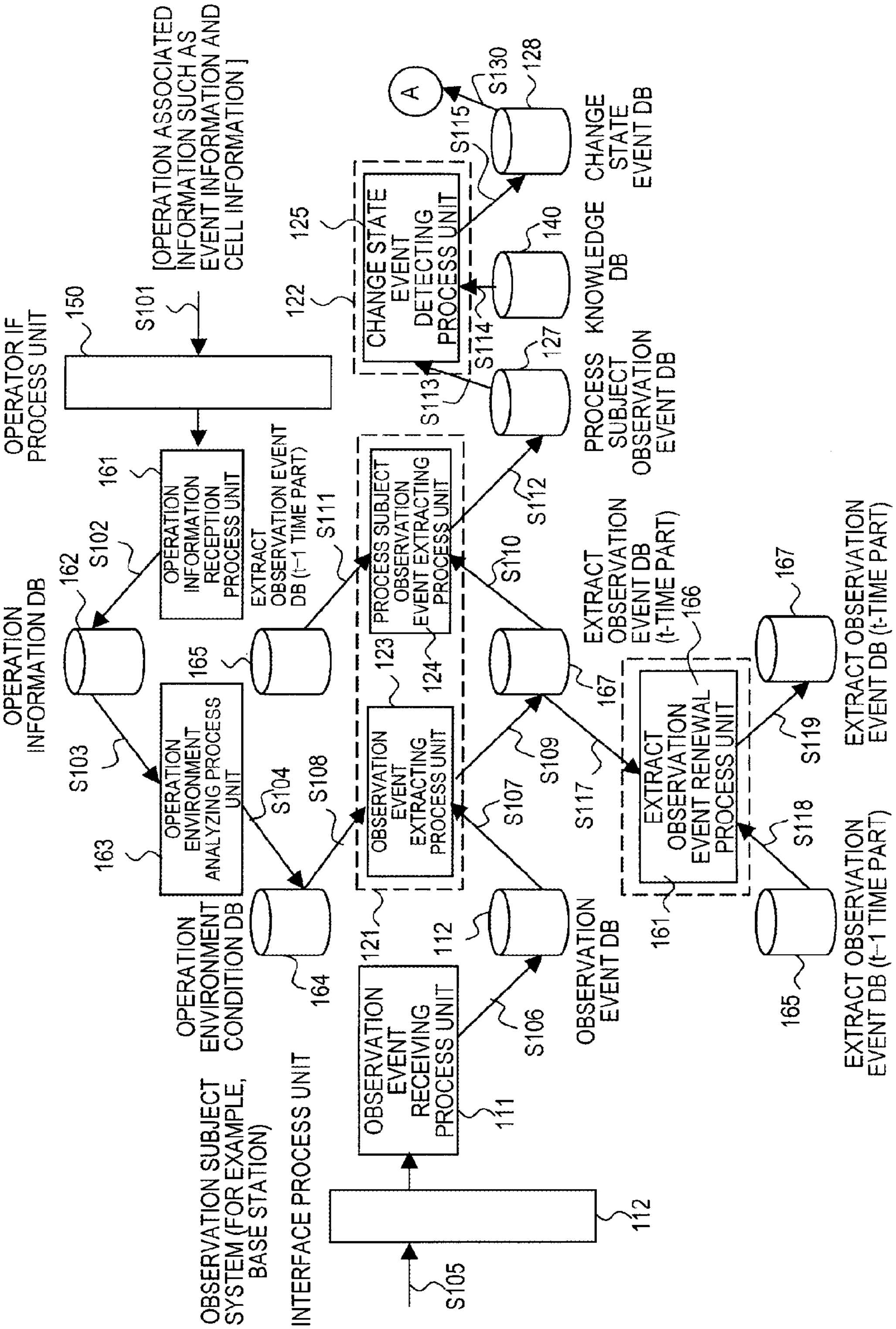
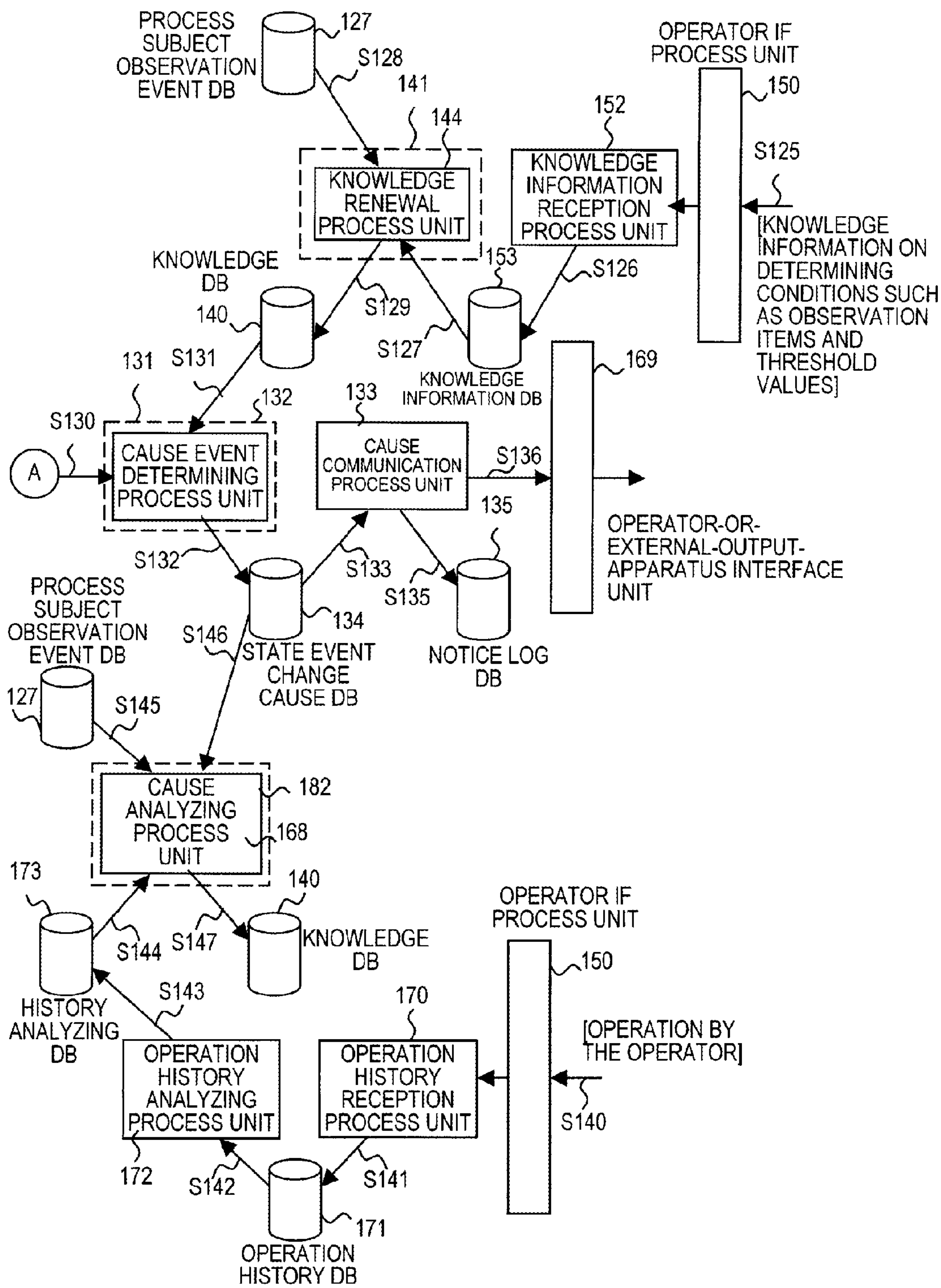

OBSERVATION SUBJECT SYSTEM (FOR EXAMPLE, BASE STATION)
INTERFACE PROCESS UNIT
S105
112
OBSERVATION EVENT RECEIVING PROCESS UNIT
111
S106
OBSERVATION EVENT DB
112
121
OPERATION ENVIRONMENT CONDITION DB
164
OPERATION ENVIRONMENT ANALYZING PROCESS UNIT
163
S103
S104
S108
S107
OBSERVATION EVENT EXTRACTING PROCESS UNIT
123
S109
OPERATION INFORMATION DB
162
165
EXTRACT OBSERVATION EVENT DB (t-1 TIME PART)
S111
124
PROCESS SUBJECT OBSERVATION EVENT EXTRACTING PROCESS UNIT
S110
167
EXTRACT OBSERVATION EVENT DB (t-TIME PART)
S117
EXTRACT OBSERVATIONAL EVENT RENEWAL PROCESS UNIT
166
161
S118
165
EXTRACT OBSERVATION EVENT DB (t-1 TIME PART)
S119
167
EXTRACT OBSERVATION EVENT DB (t-TIME PART)
OPERATION INFORMATION RECEPTION PROCESS UNIT
161
S102
S112
OPERATOR IF PROCESS UNIT
150
S101
[OPERATION ASSOCIATED INFORMATION SUCH AS EVENT INFORMATION AND CELL INFORMATION]
PROCESS SUBJECT OBSERVATION EVENT DB
127
S113
122
125
CHANGE STATE EVENT DETECTING PROCESS UNIT
S114
KNOWLEDGE DB
140
S115
CHANGE STATE EVENT DB
128
S130
A

FIG. 25


PROCESS SUBJECT OBSERVATION EVENT DB
127
S128
141
144
KNOWLEDGE RENEWAL PROCESS UNIT
152
KNOWLEDGE INFORMATION RECEPTION PROCESS UNIT
OPERATOR IF PROCESS UNIT
150
S125
[KNOWLEDGE INFORMATION ON DETERMINING CONDITIONS SUCH AS OBSERVATION ITEMS AND THRESHOLD VALUES]
KNOWLEDGE DB
140
S129
153
S126
S127
KNOWLEDGE INFORMATION DB
169
131
S131
132
133
S130
A
CAUSE EVENT DETERMINING PROCESS UNIT
CAUSE COMMUNICATION PROCESS UNIT
S136
135
OPERATOR-OR-EXTERNAL-OUTPUT-APPARATUS INTERFACE UNIT
S132
S133
S135
134
PROCESS SUBJECT OBSERVATION EVENT DB
S146
STATE EVENT CHANGE CAUSE DB
NOTICE LOG DB
127
S145
CAUSE ANALYZING PROCESS UNIT
182
168
173
140
S144
S147
KNOWLEDGE DB
OPERATOR IF PROCESS UNIT
150
HISTORY ANALYZING DB
S143
170
[OPERATION BY THE OPERATOR]
OPERATION HISTORY ANALYZING PROCESS UNIT
OPERATION HISTORY RECEPTION PROCESS UNIT
S140
172
S142
S141
171
OPERATION HISTORY DB

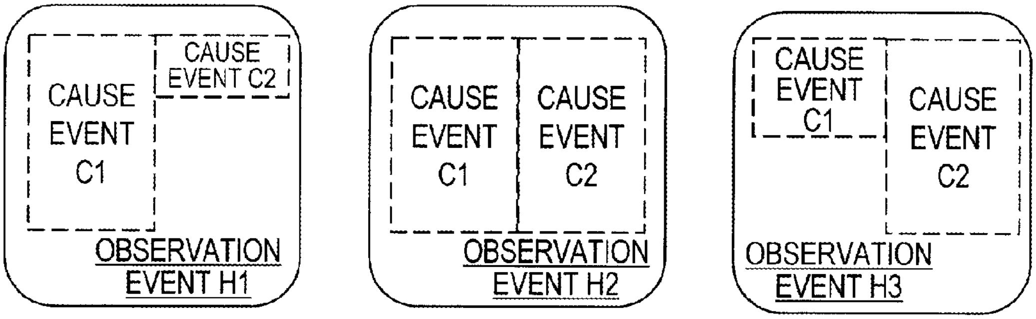


FIG. 26A FIG. 26B FIG. 26C

FIG. 27

OBSERVATION EVENT	H1	H2	H3
INITIAL(SETTING) CONDITION	0.33	0.33	0.33
FIRST TIME	0.47	0.32	0.21
SECOND TIME	0.61	0.27	0.12
THIRD TIME	0.72	0.21	0.06
FOURTH TIME	0.81	0.16	0.03
FIFTH TIME	0.87	0.11	0.02

FIG. 28

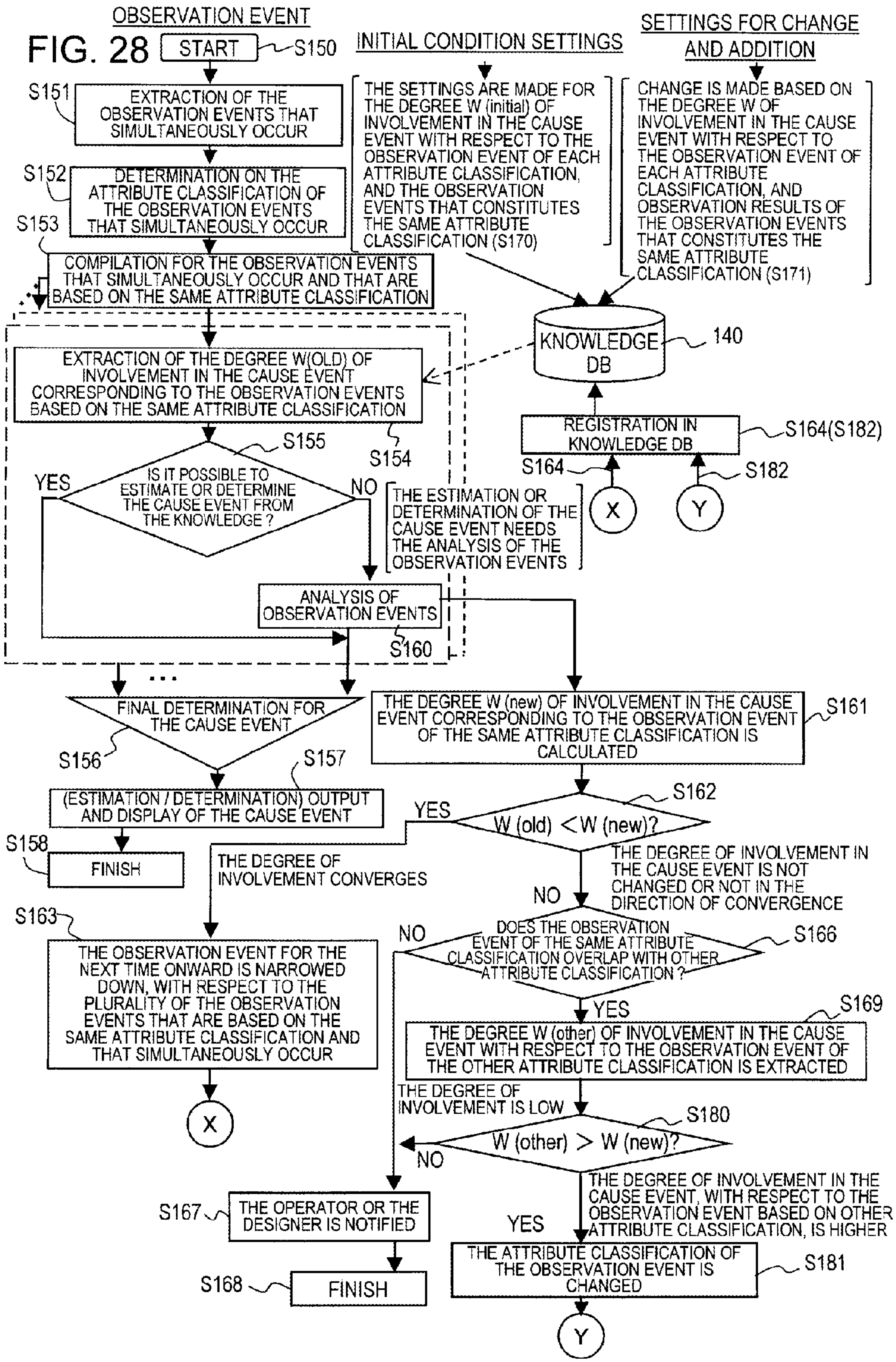

OBSERVATION EVENT
START
S150
INITIAL CONDITION SETTINGS
SETTINGS FOR CHANGE AND ADDITION
S151
EXTRACTION OF THE OBSERVATION EVENTS THAT SIMULTANEOUSLY OCCUR
S152
DETERMINATION ON THE ATTRIBUTE CLASSIFICATION OF THE OBSERVATION EVENTS THAT SIMULTANEOUSLY OCCUR
S153
COMPILATION FOR THE OBSERVATION EVENTS THAT SIMULTANEOUSLY OCCUR AND THAT ARE BASED ON THE SAME ATTRIBUTE CLASSIFICATION
THE SETTINGS ARE MADE FOR THE DEGREE W (initial) OF INVOLVEMENT IN THE CAUSE EVENT WITH RESPECT TO THE OBSERVATION EVENT OF EACH ATTRIBUTE CLASSIFICATION, AND THE OBSERVATION EVENTS THAT CONSTITUTES THE SAME ATTRIBUTE CLASSIFICATION (S170)
CHANGE IS MADE BASED ON THE DEGREE W OF INVOLVEMENT IN THE CAUSE EVENT WITH RESPECT TO THE OBSERVATION EVENT OF EACH ATTRIBUTE CLASSIFICATION, AND OBSERVATION RESULTS OF THE OBSERVATION EVENTS THAT CONSTITUTES THE SAME ATTRIBUTE CLASSIFICATION (S171)
KNOWLEDGE DB
140
EXTRACTION OF THE DEGREE W(OLD) OF INVOLVEMENT IN THE CAUSE EVENT CORRESPONDING TO THE OBSERVATION EVENTS BASED ON THE SAME ATTRIBUTE CLASSIFICATION
S154
REGISTRATION IN KNOWLEDGE DB
S164(S182)
S164
S182
X
Y
S155
YES
IS IT POSSIBLE TO ESTIMATE OR DETERMINE THE CAUSE EVENT FROM THE KNOWLEDGE ?
NO
THE ESTIMATION OR DETERMINATION OF THE CAUSE EVENT NEEDS THE ANALYSIS OF THE OBSERVATION EVENTS
ANALYSIS OF OBSERVATION EVENTS
S160
...
FINAL DETERMINATION FOR THE CAUSE EVENT
S156
S157
THE DEGREE W (new) OF INVOLVEMENT IN THE CAUSE EVENT CORRESPONDING TO THE OBSERVATION EVENT OF THE SAME ATTRIBUTE CLASSIFICATION IS CALCULATED
S161
(ESTIMATION / DETERMINATION) OUTPUT AND DISPLAY OF THE CAUSE EVENT
S162
YES
W (old) <W (new)?
S158
FINISH
THE DEGREE OF INVOLVEMENT CONVERGES
THE DEGREE OF INVOLVEMENT IN THE CAUSE EVENT IS NOT CHANGED OR NOT IN THE DIRECTION OF CONVERGENCE
NO
S163
NO
DOES THE OBSERVATION EVENT OF THE SAME ATTRIBUTE CLASSIFICATION OVERLAP WITH OTHER ATTRIBUTE CLASSIFICATION ?
S166
THE OBSERVATION EVENT FOR THE NEXT TIME ONWARD IS NARROWED DOWN, WITH RESPECT TO THE PLURALITY OF THE OBSERVATION EVENTS THAT ARE BASED ON THE SAME ATTRIBUTE CLASSIFICATION AND THAT SIMULTANEOUSLY OCCUR
YES
S169
THE DEGREE W (other) OF INVOLVEMENT IN THE CAUSE EVENT WITH RESPECT TO THE OBSERVATION EVENT OF THE OTHER ATTRIBUTE CLASSIFICATION IS EXTRACTED
THE DEGREE OF INVOLVEMENT IS LOW
S180
X
W (other) > W (new)?
NO
THE DEGREE OF INVOLVEMENT IN THE CAUSE EVENT, WITH RESPECT TO THE OBSERVATION EVENT BASED ON OTHER ATTRIBUTE CLASSIFICATION, IS HIGHER
S167
THE OPERATOR OR THE DESIGNER IS NOTIFIED
YES
THE ATTRIBUTE CLASSIFICATION OF THE OBSERVATION EVENT IS CHANGED
S181
S168
FINISH
Y

FIG. 29

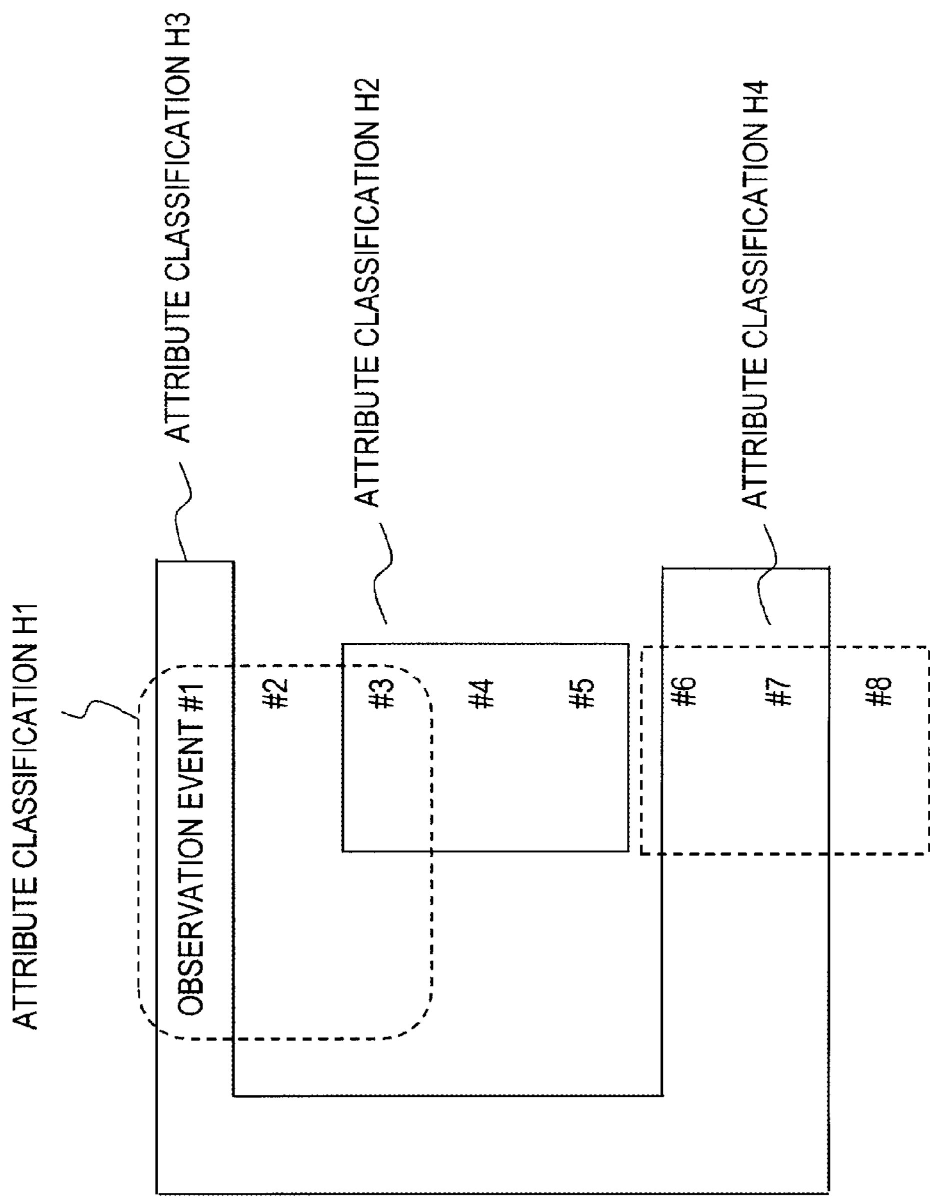

ATTRIBUTE CLASSIFICATION H3
ATTRIBUTE CLASSIFICATION H2
ATTRIBUTE CLASSIFICATION H4
ATTRIBUTE CLASSIFICATION H1
OBSERVATION EVENT #1
#2
#3
#4
#5
#6
#7
#8

FIG. 30

EXTRACTION OF THE OBSERVATION DATA (TIME SERIES)

FILE(F) EDIT(E) DISPLAY(V) INQUIRY TABLE(N) CONNECTION(C) DATA MART GENERATION(M) TOOL(T) WINDOW(W) HELP(H)

DATE	TIME	BTS NUMBER	THE NUMBER OF COMMUNICATIONS AT RATE 1	CALL THROUGHPUT	ERLANG NUMBER	CONNECTION RATIOA	ID	
2004/11/20	0:00:00	51	762	762	7	92.2	2004/11/200:00:00	51
2004/11/21	0:00:00	51	955	955	8	93.2	2004/11/210:00:00	51
2004/11/25	0:00:00	51	1,111	1,111	11	93.0	2004/11/250:00:00	51
2004/11/26	0:00:00	51	1,082	1,082	10	94.5	2004/11/260:00:00	51
2004/11/27	0:00:00	51	1,088	1,088	10	90.6	2004/11/270:00:00	51
2004/11/28	0:00:00	51	937	937	9	95.7	2004/11/280:00:00	51
2004/11/29	0:00:00	51	1,125	1,125	11	93.2	2004/11/290:00:00	51
2004/11/30	0:00:00	51	998	998	9	81.3	2004/11/300:00:00	51
2004/12/1	0:00:00	51	783	783	9	94.2	2004/12/1 0:00:00	51
2004/12/10	0:00:00	51	867	867	10	92.4	2004/12/100:00:00	51
2004/12/11	0:00:00	51	963	963	12	92.9	2004/12/110:00:00	51
2004/12/12	0:00:00	51	810	810	13	91.7	2004/12/120:00:00	51
2004/12/13	0:00:00	51	1,040	1,040	9	94.3	2004/12/130:00:00	51
2004/112/14	0:00:00	51	758	758	9	90.8	2004/12/140:00:00	51
2004/12/15	0:00:00	51	870	870	9	91.1	2004/12/150:00:00	51
2004/12/2	0:00:00	51	764	764	8	90.0	2004/12/2 0:00:00	51
2004/12/28	0:00:00	51	595	595	7	87.5	2004/12/280:00:00	51
2004/12/29	0:00:00	51	692	692	7	90.7	2004/12/290:00:00	51
2004/12/3	0:00:00	51	767	767	9	92.8	2004/12/3 0:00:00	51
2004/12/30	0:00:00	51	572	572	8	85.9	2004/12/300:00:00	51
2004/12/31	0:00:00	51	744	744	9	87.4	2004/12/310:00:00	51

PRESS [F1] TO DISPLAY HELP

NUM

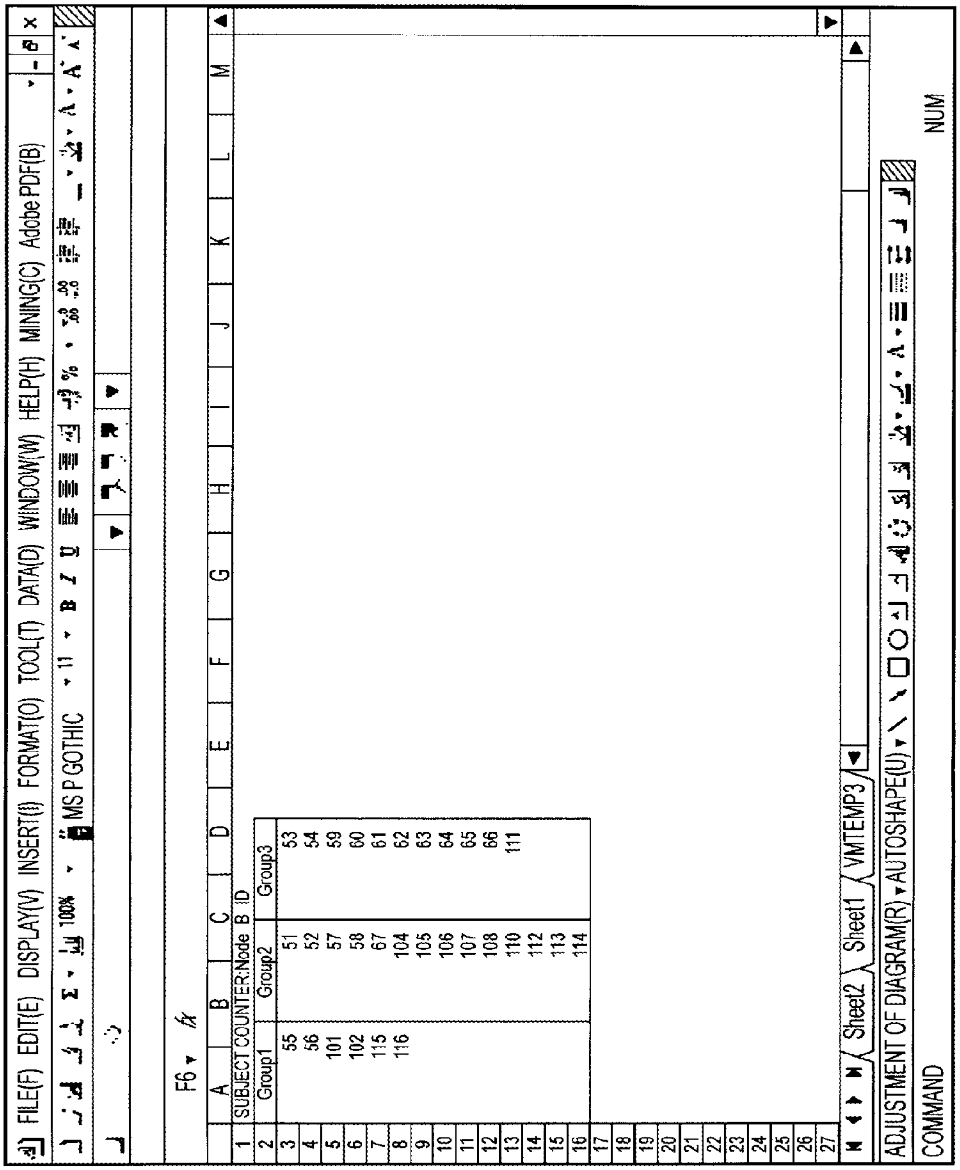
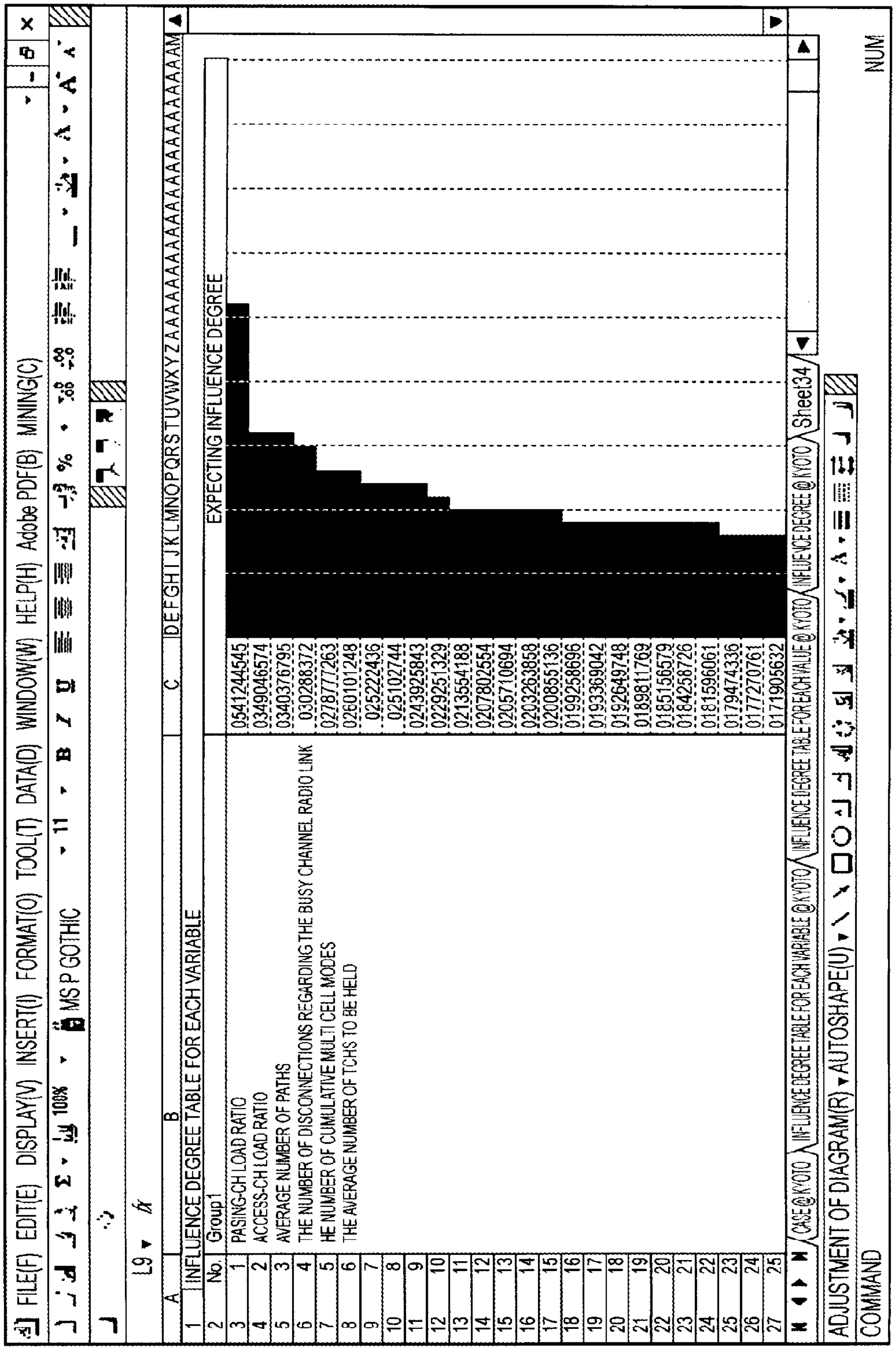

FILE(F) EDIT(E) DISPLAY(V) INSERT(I) FORMAT(O) TOOL(T) DATA(D) WINDOW(W) HELP(H) MINING(C) Adobe PDF(B)
MS P GOTHIC
F6
SUBJECT COUNTER:Node B ID
Group1
55
56
101
102
115
116
Group2
51
52
57
58
67
104
105
106
107
108
110
112
113
114
Group3
53
54
59
60
61
62
63
64
65
66
111
Sheet2
Sheet1
VMTEMP3
ADJUSTMENT OF DIAGRAM(R)
AUTOSHAPE(U)
COMMAND
NUM

FIG. 31

FIG. 32


FILE(F) EDIT(E) DISPLAY(V) INSERT(I) FORMAT(O) TOOL(T) DATA(D) WINDOW(W) HELP(H) Adobe PDF(B) MINING(C)
MS P GOTHIC
INFLUENCE DEGREE TABLE FOR EACH VARIABLE
No.
Group1
PASING-CH LOAD RATIO
ACCESS-CH LOAD RATIO
AVERAGE NUMBER OF PATHS
THE NUMBER OF DISCONNECTIONS REGARDING THE BUSY CHANNEL RADIO LINK
HE NUMBER OF CUMULATIVE MULTI CELL MODES
THE AVERAGE NUMBER OF TCHS TO BE HELD
EXPECTING INFLUENCE DEGREE
0541244545
0349046574
0340376795
030288372
0278777263
0260101248
025222436
0251027444
0243925843
0229251329
0213554188
0207802554
0205710694
0203263858
0200855136
0199258696
0193369042
0192649748
0189811769
0185156579
0184258726
0181596061
0179474336
0177270761
0171905632
CASE@KYOTO
INFLUENCE DEGREE TABLE FOR EACH VARIABLE @KYOTO
INFLUENCE DEGREE TABLE FOR EACH VALUE @KYOTO
INFLUENCE DEGREE @KYOTO
Sheet34
ADJUSTMENT OF DIAGRAM(R)
AUTOSHAPE(U)
COMMAND
NUM

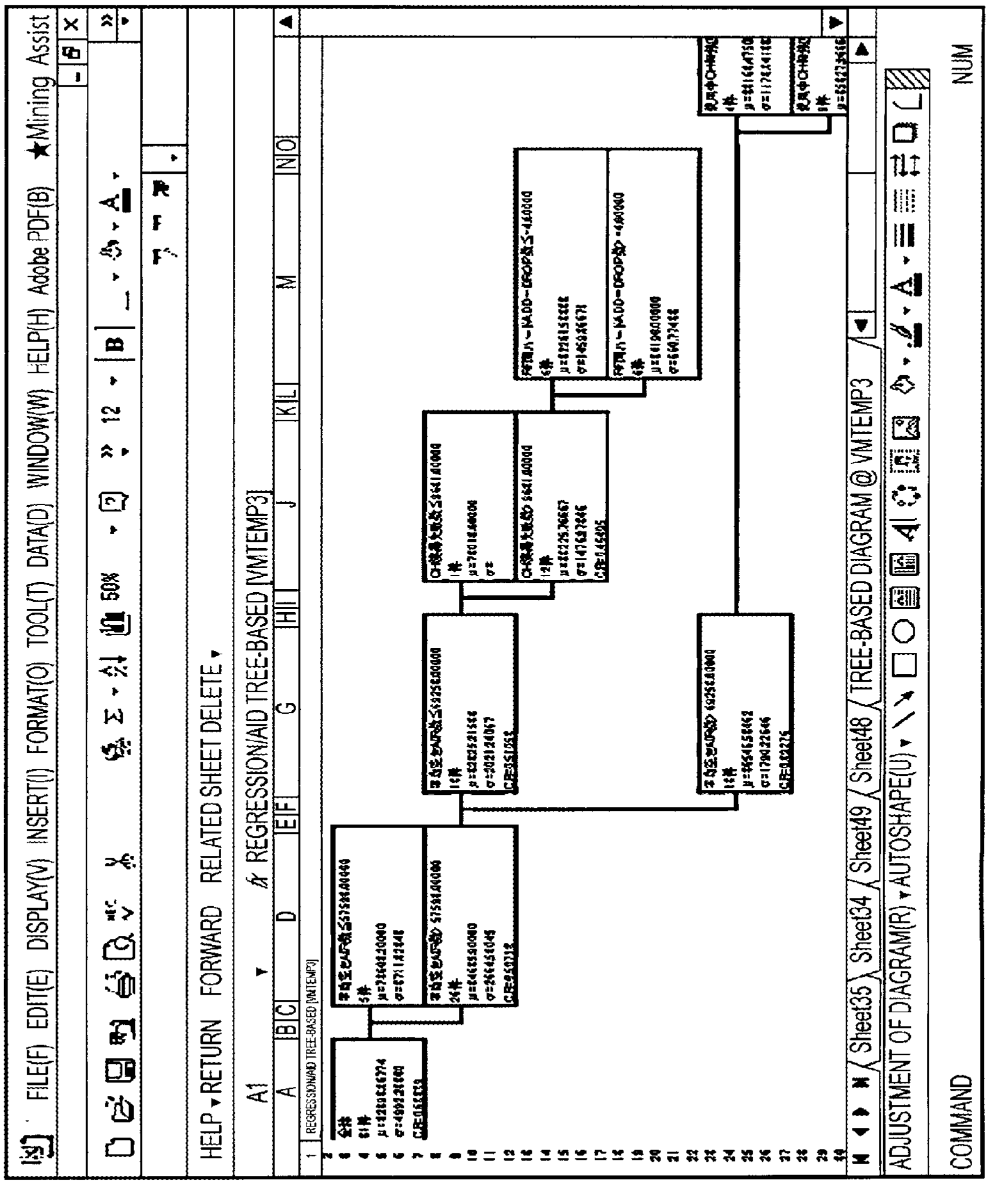
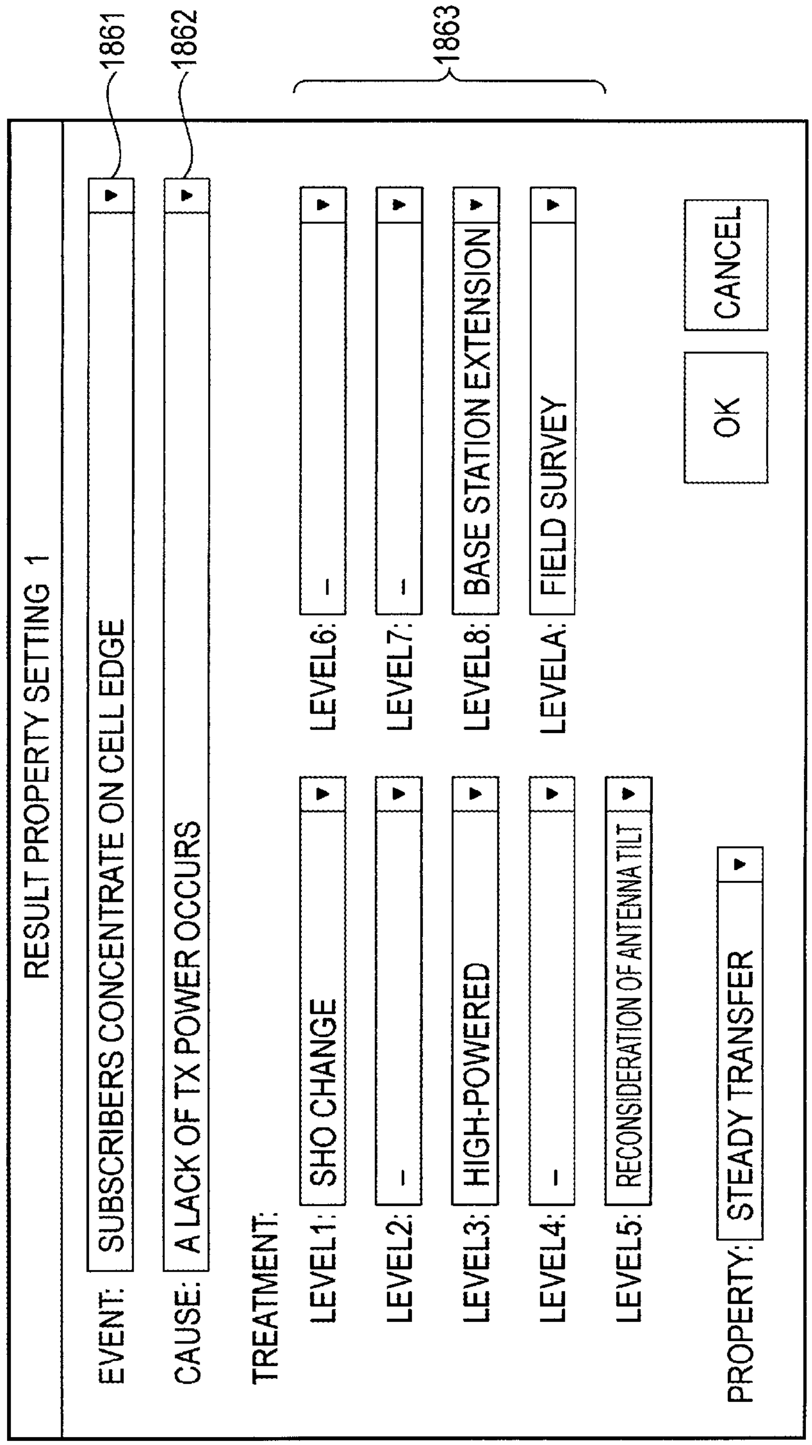

FILE(F) EDIT(E) DISPLAY(V) INSERT(I) FORMAT(O) TOOL(T) DATA(D) WINDOW(W) HELP(H) Adobe PDF(B) ★Mining Assist
HELP ▾ RETURN FORWARD RELATED SHEET DELETE ▾
A1
REGRESSION/AID TREE-BASED [VMTEMP3]
Sheet35 Sheet34 Sheet49 Sheet48 TREE-BASED DIAGRAM @ VMTEMP3
ADJUSTMENT OF DIAGRAM(R) ▾ AUTOSHAPE(U) ▾
COMMAND
NUM

FIG. 33

FIG. 34


RESULT PROPERTY SETTING 1
EVENT:
SUBSCRIBERS CONCENTRATE ON CELL EDGE
1861
CAUSE:
A LACK OF TX POWER OCCURS
1862
TREATMENT:
1863
LEVEL1:
SHO CHANGE
LEVEL2:
-
LEVEL3:
HIGH-POWERED
LEVEL4:
-
LEVEL5:
RECONSIDERATION OF ANTENNA TILT
LEVEL6:
-
LEVEL7:
-
LEVEL8:
BASE STATION EXTENSION
LEVELA:
FIELD SURVEY
PROPERTY:
STEADY TRANSFER
OK
CANCEL

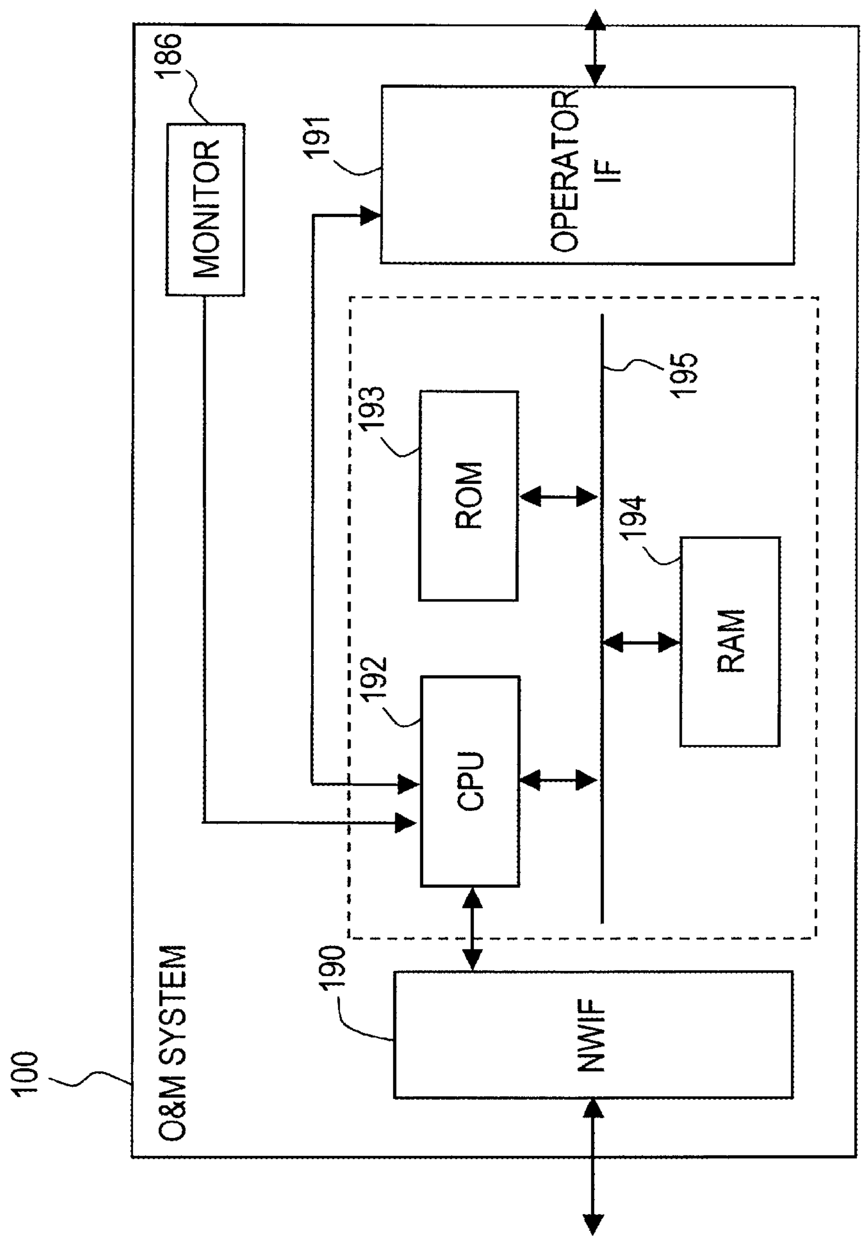

O&M SYSTEM
100
186
MONITOR
191
OPERATOR
IF
193
ROM
195
194
RAM
192
CPU
190
NWIF

FIG. 35

OPERATION MONITORING APPARATUS, CAUSE EVENT ESTIMATING METHOD FOR THE SAME, AND INFORMATION COMMUNICATION NETWORK SYSTEM

CROSS-REFERENCE TO RELATED APPLICATION

This application is based upon and claims the benefit of priority of the prior Japanese Patent Application No. 2012-130198, filed on Jun. 7, 2012, the entire contents of which are incorporated herein by reference.

FIELD

The embodiments discussed herein are related to an operation monitoring apparatus, a cause event estimating method for the same, and an information communication network system.

BACKGROUND

In these days, an information communication network systems such as a cellular phone and internet have advanced with increasing speed in respect of complexity and scale. In accordance with the advancement, an operator or surveillant engaged in the operation businesses or monitoring business of the information communication network system have the difficulty in accurately grasping the operational state on the system.

For example, one example of the information communication network systems includes a system typified by the cellular phone. In the system, there is a case where the observation data regarding the operational and radio environmental states of a base station and the cellular phone is observed in unit of hundred of items in the base station. Moreover, the number of base stations sometimes reaches tens of thousands. Accordingly, the amount of observation data to be collected increases to an extraordinary degree, and it is difficult for the operator or the surveillant to accurately grasp the operational state of the information communication network system.

In particular, the operation or monitoring business of the information communication network system include individual characteristic in the system (or unique to the system) and an element (or factor) that exerts influence on the characteristic. As a result, the operator or surveillant depends on individual skill such as associated knowledge and experience in the operation or monitoring businesses. Accordingly, it is a problem in the management or monitoring businesses to be qualitatively maintained and improved in the information communication network system.

In order to compensate for a lack of knowledge or experience for the manager or surveillant, for example, there is a case where a data mining technology is applied. The data mining technology, for example, is a technology that data analyzing technique such as artificial intelligence and so on is applied to a large amount of data, and knowledge is taken out.

However, regarding the data mining technique, for example, the processing time increases in accordance with the expansion or complication of the system, when the information communication network system is expanded or complicated. Accordingly, there is a limit in the case where the data mining technique is applied to the information communication network system.

Under the circumstances, for example, there is a technology as follows. That is, there is the technology that candidate for failure part based on each alarm signal is estimated, the

failure part is identified automatically by finding a common set between the candidates for failure parts, and a part where failure occurs is diagnosed promptly by analyzing the factor of occurrence of the failure to be identified in accordance with the instructions by the operator.

Further, there is a causality relation derivation system to analyze the causality relation of data in appropriate memory capacity and processing time, by collecting data regarding yield of a product and calculating the causality relation of a multitude of data with a conditional probability, in a causality relation derivation kernel interface.

Japanese Laid-open Patent Publication No. 05-114899

Japanese Laid-open Patent Publication No. 2000-288877

However, the technology of estimating the candidates for failure part described above and the technology of calculating the causality relation with the conditional probability are aimed at estimating the failure part or calculating the causality relation of multitude of data. Accordingly, the technologies described above, for example, make it possible to estimate the failure part, but fail to notify the operator or surveillant what cause of the occurrence of failure is. Further, the technologies described above make it possible to calculate the causality relation of data, but fail to notify the operator or the surveillant what the cause hiding behind the data is.

Accordingly, in the information communication network system, the technologies described above fail to notify the operator or the surveillant what the cause hiding behind the observation data is, and what way to cope with the cause is, in a huge mass of the observation data.

For example, there is a case where fluctuation in traffic is monitored by the operator or the surveillant in the information communication network system typified by the cellular phone. The fluctuation in traffic has a characteristic of being substantially affected by transfer of the cellular phone and regional property (for example, residential area and business area), for example. Accordingly, it is difficult to instantly identify the cause such as the transfer of cellular phone, the regional property, and so on, which are attributed to the acquisition of the observation data, from the observation data collected by the base station regarding the fluctuations in traffic.

Or, it is difficult to instantly determine whether the cause of the deterioration is ascribed to the process ability of a system apparatus (for example, base station control apparatus) or a lack of radio resource and appropriately respond in the information communication network system, when value of the observation data is transferred in direction of deterioration with respect to a threshold value.

For example, in any one of the two technologies described above, it fails to identify cause of acquisition of the observation date based on the observation date.

Further, in the technologies described above, for example, there is no argument as to how appropriate observation data is identified or narrowed when the huge mass of observation data is obtained in the information communication network system. When the cause is identified from the huge mass of observation data in the information communication network system, there is a case that it takes a lot of time to identify the cause.

SUMMARY

According to an aspect of the embodiments, an operation monitoring apparatus for estimating a cause by which a first and second observation data observed by a monitored apparatus are obtained, the operation monitoring apparatus including: an observation event receiving process unit which receives the first and second observation data transmitted from the monitored apparatus; an observation event extracting unit which extracts the first observation data, out of the first and second observation data, based on a probability that the cause occurs with respect to the first and second observation data; a cause event determining process unit which estimates the cause based on the extracted first observation data; and a cause notifying process unit which outputs data indicating the estimated cause.

The object and advantages of the invention will be realized and attained by means of the elements and combinations particularly pointed out in the claims.

It is to be understood that both the foregoing general description and the following detailed description are exemplary and explanatory and are not restrictive of the invention.

BRIEF DESCRIPTION OF DRAWINGS

FIG. **1** is a diagram illustrating an example of the configuration of an information communication network system;

FIG. **2** is a diagram illustrating an example of the configuration of the information communication network system;

FIG. **3** is a diagram illustrating an example of the configuration of an O&M system;

FIG. **4** is a diagram illustrating an example of the configuration of the O&M system;

FIG. **5** is a flowchart illustrating an example of the entire operation in the O&M system;

FIG. **6** is a diagram illustrating an example of an observation model;

FIG. **7** is a diagram illustrating an example of a system model;

FIG. **8** is a diagram illustrating an example of an entire model;

FIG. **9**A is a diagram illustrating an example of time displacement in observation value distribution, and FIG. **9**B is a diagram illustrating an example of time displacement in state distribution;

FIG. **10** is a diagram illustrating an example of an implementation model;

FIG. **11** is a flowchart schematically illustrating an example of a cause event estimating method;

FIG. **12** is a diagram illustrating an example of observation result;

FIG. **13** is a flowchart illustrating an example of processes in the O&M system;

FIG. **14** is a diagram illustrating an example of observation event;

FIG. **15** is a flowchart illustrating an example of processes in the O&M system;

FIG. **16** is a diagram illustrating an example of the observation event;

FIG. **17** is a diagram illustrating an example of the cause event;

FIG. **18** is a diagram illustrating an example of a table to estimate the cause event;

FIGS. **19**A and **19**B are diagrams illustrating examples of the table for estimating the cause event;

FIG. **20** is a flowchart illustrating an example of estimating the cause event;

FIG. **21** is a diagram illustrating an example of coping method to the observation event and estimated cause event;

FIG. **22** is a flowchart illustrating an example of process in the O&M system;

FIG. **23** is a diagram illustrating an example of the observation event;

FIG. **24** is a diagram illustrating an example of process in the O&M system;

FIG. **25** is a diagram illustrating an example of process in the O&M system;

FIGS. **26**A to **26**C are diagrams illustrating examples of the relation between the observation event and cause event;

FIG. **27** is a diagram illustrating an example of calculation result of a degree of involvement to the observation event;

FIG. **28** is a flowchart illustrating an example of process to the degree of involvement;

FIG. **29** is a diagram illustrating an example of the observation event based on same attribute classification;

FIG. **30** is a diagram illustrating an example of screen display for the observation data;

FIG. **31** is a diagram illustrating an example of the screen display for count value of the observation event included in each group;

FIG. **32** is a diagram illustrating an example of the screen display for the degree of involvement in the cause event in a graphic form;

FIG. **33** is a diagram illustrating an example of the screen display for the degree of involvement in a tree-based form;

FIG. **34** is a diagram illustrating an example of the screen display on which the cause event and coping method to the cause event are displayed; and

FIG. **35** is a diagram illustrating an example of another configuration of the O&M system.

DESCRIPTION OF EMBODIMENTS

Hereinafter, the embodiments of the present invention will be described.

First Embodiment

First, a first embodiment will be described. FIG. **1** is a diagram illustrating an example of the configuration of an information communication network system **10** according to the first embodiment. The information communication network system **10** includes a monitored apparatus **350** and an operation monitoring apparatus **600**.

The monitored apparatus **350** observes a first observation data and second observation data. The monitored apparatus **350** transmits the observed first and second observation data to the operation monitoring apparatus **600**.

The operation monitoring apparatus **600** monitors the monitored apparatus **350** and estimates cause by which the first and second observation data are obtained with respect to the first and second observation data observed by the monitored apparatus **350**, for example.

As illustrated in FIG. **1**, the operation monitoring apparatus **600** includes an observation event receiving process unit **111**, an observation event extracting unit **121**, a cause event determining process unit **131**, and a cause communication process unit **133**.

The observation event receiving process unit **111** receives the first and second observation data transmitted from the monitored apparatus **350**.

The observation event extracting unit **121** extracts the first observation data, out of the first observation data and second observation data, based on probability that cause occurs with respect to the first and second observation data occurs.

The cause event determining process unit **131** estimates the cause based on the extracted first observation data.

The cause communication process unit **133** outputs data indicating the estimated cause.

Thus, the operation monitoring apparatus **600** extracts target observation data being subject to estimate the cause, based on the probability of occurrence of the cause, of the first and second observation data obtained from the monitored apparatus **350**, for example.

Accordingly, even when the operation monitoring apparatus **600** obtains a huge mass of observation data (or observation events), the operation monitoring apparatus **600** can extract the observation data being subject to estimate the cause (or cause event), out of the huge mass of observation data, and can estimate the cause based on the extracted observation data, for example. Consequently, the operation monitoring apparatus **600** can estimate the cause event from the huge mass of observation data.

The operation monitoring apparatus **600** can output data indicating the cause estimated by the cause communication process unit **133**. For example, the operation monitoring apparatus **600** is connected to a display unit such as a monitor, a display, or the like, and can notify via the display unit an operator and surveillant of the cause by which the first and second observation data are obtained, by outputting the data indicating the cause to the display unit.

For example, the operator or the surveillant can take various coping method to the information communication network system **10** based on the cause displayed on the display unit, thereby decision-making for the operator or the surveillant can be supported.

Further, the operation monitoring apparatus **600** appropriately transmits the data indicating the cause to the display units, thereby the cause is displayed in time series. Accordingly, for example, the operator or the surveillant can recognize the time-series change of the cause and recognize the change or displacement in the operational state of the information communication network system **10**. Consequently, the operation monitoring apparatus **600** can appropriately notify the operator or the surveillant of the change or displacement in the operational state of the information communication network system **10**.

Second Embodiment

Next, a second embodiment will be described. The second embodiment will be described in the following order, aimed at facilitating easy understanding.

First, an example of the entire configuration of the information communication network system according to second embodiment will be described. For example, FIG. **2** is a diagram illustrating an example of the entire configuration of the information communication network system **10**.

Next, the example of the configuration of an O&M (Operation and Maintenance) system **100** in the information communication network system **10** will be described.

For example, the O&M system **100** is a server or operation monitoring apparatus that estimates the cause by which the observation data is obtained (or the cause hiding behind the observation data), based on the observation data to be observed or collected in the information communication network system **10**, and further provides way to cope with the cause. For example, the O&M system **100** corresponds to the operation monitoring apparatus **600** in the first embodiment.

For example, the O&M system **100** notify the operator of the estimated cause, so that the operator can recognize the operational state of the information communication network system **10**. Further, the O&M system **100** notifies the operator of the cope method, so that the operator can perform appropriate way immediately.

In the embodiments of the present invention, for example, it is noted that there is a case where the observation data is referred to as an observation event, and the cause obtained based on the observation data (or cause hiding behind the observation data) is referred to as a cause event.

In particular, in the second embodiment, the O&M system **100** can identify which the observation event to focus on, and estimate the cause event from the identified observation event. For example, FIGS. **3** and **4** are diagrams illustrating examples of the configuration of the O&M system **100**.

Next, an example of the entire operation in the O&M system **100** will be described. FIG. **5** is a flowchart illustrating an example of the operation of the O&M system **100**.

Next, the relation between the observation event and cause event will be described by modeling the observation event and so on. Further, an example of implementation model as to how the cause event is estimated in the O&M system **100** will be described. FIGS. **6** to **10** are diagrams illustrating respective examples of the model.

Next, a concrete example of a method of estimating the cause event and concrete processing example in the O&M system **100** will be described. In the description, each concrete example of the observation event and the cause event will be described. Further, a concrete example of a coping method being provided by the O&M system **100** provides will be described. FIGS. **13** to **23** are diagrams respectively illustrating examples of the process.

Next, an operation example of estimating the cause event and providing the coping method will be described. In the description, the processes described in FIGS. **11** to **23** are described together as an example of the entire operation. FIGS. **24** and **25** are diagrams respectively illustrating examples of the operation.

Finally, a narrowing process to estimate or determine the cause event with respect to the observed or collected observation event will be described. Accordingly, for example, the observation event which is subject to be observed is narrowed down from a huge mass of observation events in the O&M system **100**, and a process of estimating or determining the cause event can be carried out based on the narrowed observation event. The O&M system **100** can refine the cause event hidden in the observation event and simplify the process, by carrying out the process. FIGS. **26**A to **29** are diagrams respectively illustrating operation examples of the narrowing process.

<Configuration Example of Information Communication Network System **10**>

FIG. **2** is the diagram illustrating a configuration example of the information communication network system **10**. For example, the information communication network system **10** can be applied to a large-scale information processing system such as a banking system in bank, a data center system managing customer information in credit card company, or the like. For example, the information communication network system **10** illustrated in FIG. **2** is exemplified as a mobile communication system.

The information communication network system **10** includes the O&M system or a server (hereinafter, also referred to as "O&M system") **100**, a mobile information terminal **200** (**200-1**, **200-2**, . . . , **200**-*n*), a mobile communication network **300**, a GW (gateway) **400**, and an another network **500**.

The mobile information terminal **200** can perform radio communication with a radio base station (not illustrated) connected to the mobile communication network **300**. The mobile information terminal **200** can transmit and receive data to and from a server connected to the another network **500** or an another mobile information terminal **200** wirelessly connected to an another radio base station, via the radio base station. For example, the mobile information terminal **200** is a portable information terminal such as a feature phone, a smart phone, a PDA (Personal Digital Assistance), and so on. For example, the mobile information terminal **200** is a monitored apparatus in the O&M system **100**. Further, the mobile information terminal **200** corresponds to the monitored apparatus **350** in the first embodiment.

For example, the mobile communication network **300** is a network to be connected when the mobile information terminal **200** performs communication. The mobile communication network **300** is connected to a radio base station control apparatus controlling one radio base station or more, for example. For example, when data is transmitted and received between the mobile information terminal **200** and the server, the radio base station includes a function of relaying the data, by way of converting the data into radio signal. For example, the radio base station also is the monitored apparatus in the O&M system **100** and corresponds to the monitored apparatus **350** in the first embodiment.

The O&M system **100** is connected to the mobile communication network **300**, and performs operation or monitoring of the operational state of the information communication network system **10**, for example. That is, the O&M system **100** can estimate or determine (hereinafter, also referred to as "estimate") the cause by which the observation data is obtained (or cause hiding behind the observation data) based on the observed or collected observation data, and can provide (or output) the coping method. In this time, the O&M system **100** performs the narrowing process based on the observed observation events and performs estimating process of the cause event based on the narrowed observation event. The processes performed in the O&M system **100** will be described later in detail. It is noted that the O&M system **100** corresponds to the operation monitoring apparatus **600** in the first embodiment, for example.

The subjecting observation events observed by the O&M system **100** include the radio base station connected to the mobile information terminal **200** or the mobile communication network **300**, the radio base station control apparatus, the GW **400**, the server connected to the another network **500**, the mobile communication network **300**, and the another network **500**, for example. However, in the second embodiment, in order to facilitate easy understanding, the mobile communication network **300** and the mobile information terminal **200** will be described in below as a subject of the observation event.

The GW **400** is a node connecting the mobile communication network **300** with the another network **500** and converts the protocol of data passing through the mobile communication network **300** and the another network **500**, for example.

The another network **500** is a communication network performing transmission and reception by TCP/IP (Transmission Control Protocol/Internet Protocol), for example. The another network **500** is connected to a server providing internet services, and so on, for example. The server can transmit and receive data to and from the mobile information terminal **200**.

<Example of Configuration O&M System **100**>

FIGS. **3** and **4** are diagrams illustrating examples of the configuration of the O&M system **100**. The example of the configuration of the O&M system **100** illustrated in FIG. **4** represents a more detailed illustration, compared with the example of the configuration of the O&M system **100** illustrated in FIG. **3**.

The O&M system **100** illustrated in FIG. **3** will be described. The O&M system **100** includes a NWIF (network interface) process unit **110**, an observation event process unit **120**, a cause event determining unit **130**, a knowledge DB **140**, and an operator IF process unit **150**.

The NWIF process unit **110** is connected to the mobile communication network **300** (or the radio base station control apparatus, or the like) and receives the observation event observed in the base station, or the like, for example. The NWIF process unit **110** converts the observation event received from the mobile communication network **300** into data having a format processable in the O&M system **100**, and outputs the converted data to the observation event process unit **120**, for example.

The observation event process unit **120** performs the narrowing process to estimate the cause event with respect to the observation event received from the NWIF process unit **110**, for example. In this time, the observation event process unit **120** can also perform the narrowing process of the observation event based on associated information received from the operator IF process unit **150**, for example. The detail of the associated information and so on will be described below. And, the observation event process unit **120** stores the narrowed observation event in the knowledge DB **140** and outputs the narrowed observation event to the cause event determining unit **130**, for example. Further, the observation event process unit **120** extracts a distinctive factor from the narrowed observation event (detects a changing state event or the like) and outputs the distinctive factor to the cause event determining unit **130**. The detail of the observation event process unit **120** will be described below.

The cause event determining unit **130** receives the observation event and the distinctive factor from the observation event process unit **120** and estimates the cause event to be assumed with respect to the observation event, for example. The cause event determining unit **130** outputs the estimated cause event to the operator IF process unit **150** and stores the estimated cause event in the knowledge DB **140**, for example. The detail of the estimating process of the cause event and so on will be described below.

The knowledge DB **140** stores the observation event narrowed by the observation event process unit **120** and the cause event estimated by the cause event determining unit **130** (or data indicating the cause event, and hereinafter the cause event and the data indicating the cause event are not distinguished, but merely referred to as the "cause event"), for example. The events registered in the knowledge DB **140** is referred to as "knowledge information", for example. In the diagrams, there is a case of illustrating as a phrase of "Na-Re-Ji", however there is a case of referring the phrase of "Na-Re-Ji" as "knowledge" in the specification.

The operator IF process unit **150** is connected to a monitor and a keyboard manipulated by the operator and performs process of converting data format so as to display the cause event output from the cause event determining unit **130** on the monitor and so on, for example. The operator IF process unit **150** receives observation item and associated information specified by the operator by means of the keyboard manipulated by the operator and converts the received observation item and associated information into data having a format processable in the O&M system **100**, for example. And, the operator IF process unit **150** registers the received observation item in the knowledge DB **140** and outputs the associated information to the observation event process unit **120**, for example.

FIG. **4** is a diagram illustrating an example of the detailed configuration of the O&M system **100**. The O&M system **100** includes the observation event receiving process unit **111**, an associated information receiving process unit **160**, the observation event extracting unit **121**, an observation event analyzing process unit **122**, the cause event determining process unit **131**, a statistical analysis process unit **180**, a knowledge addition/correction process unit **141**, a knowledge registering process unit **142**, an operator requirement receiving process unit **151**, a cope history process unit **182**, a display editing unit **184**, and a monitor **186**.

In view of the correlation between the O&M systems **100** in FIGS. **3** and **4**, the NWIF process unit **110** in FIG. **3** corresponds to the observation event receiving process unit **111**, for example. The observation event process unit **120** in FIG. **3** corresponds to the observation event extracting unit **121** and the observation event analyzing process unit **122**, for example. Further, the knowledge DB **140** in FIG. **3** is held in the knowledge registering process unit **142**, for example. Further, the operator IF process unit **150** in FIG. **3** corresponds to the operator requirement receiving process unit **151**, for example.

The observation event receiving process unit **111** receives the observation event (or observation data) observed in the base station, for example. The observation event receiving process unit **111** receives the observation event in time series in the order of an observation event at a time n, an observation event at a time (n+1), or the like, for example.

There is "transmission power increase" and "position registration impossibility" as the observation event, for example. Although the detail of the observation event is described below, the examples of the observation event are illustrated in FIG. **14**. Or, there is an information on value of transmission power, presence or absence of position registration and so on, as the observation event, and the observation event receiving process unit **111** can obtain the observation event such as "transmission power increase" and "position registration impossibility" by comparing the received information with a threshold value, for example.

The associated information receiving process unit **160** receives the associated information (or operation information) from the operator requirement receiving process unit **151** and outputs the received associated information to the observation event extracting unit **121**, for example. The associated information includes event information and cell information, for example. The event information includes an information relating to an event such as a concert in a certain area or a firework event in a place. The cell information includes an information relating to the base station such as an information indicating that a certain base station is out of order, or the certain base station is temporarily halted, for example.

The observation event extracting unit **121** performs the narrowing process with respect to the observation event and outputs the narrowed observation event to the observation event analyzing process unit **122** and the knowledge addition/correction process unit **141**, for example. The observation event extracting unit **121** can refer to the associated information in performing the narrowing process, for example. The detail of the narrowing process will be described below.

The observation event analyzing process unit **122** extracts the distinctive factor and so on with respect to the narrowed observation event, for example. For example, the observation event analyzing process unit **122** can extract the distinctive factor by detecting a state change with respect to the narrowed observation event to. The observation event analyzing process unit **122** outputs the extracted distinctive factor and the narrowed observation event to the cause event determining process unit **131**.

The cause event determining process unit **131** estimates (or determines) the cause event to be assumed with respect to the observation event based on the distinctive factor, for example. The detail of the estimating process will be described below.

The statistical analysis process unit **180** analyzes in time series the observation event obtained by the observation event analyzing process unit **122** and the cause event obtained by the cause event determining process unit **131**, analyzes association or correlation with similar event in the past, and registers the result in the knowledge DB **140** via the knowledge addition/correction process unit **141**, for example. For example, when there is a change of the observation event between a certain time zone and a time zone prior to the certain time zone, the statistical analysis process unit **180** can overwrite the observation event at the certain time zone in the knowledge DB **140**.

The knowledge addition/correction process unit **141** outputs the observation event and the cause event respectively obtained by the observation event extracting unit **121** and the cause event determining process unit **131**, the result obtained by the statistical analysis process unit **180**, and the manipulation history of the operator, obtained by the cope history process unit **182**, and so on, to the knowledge registering process unit **142**, for example. Accordingly, the knowledge addition/correction process unit **141** can add and registers the cause event and so on, in the knowledge DB **140**.

The knowledge registering process unit **142** includes the knowledge DB **140**, accesses the knowledge DB **140**, and registers (or stores) the output from the knowledge addition/correction process unit **141** in the knowledge DB **140**, for example. The knowledge registering process unit **142** can also read out the cause event stored in the knowledge DB **140** based on the requirement from the cause event determining process unit **131** or the like, and output the cause event to the cause event determining process unit **131**, for example.

The operator requirement receiving process unit **151** receives the observation items required by the operator, a collection period, the registration and correction of the observation event such as a cell to be observed or the like, a threshold condition of the observation data, a subject item to be narrowed, a specification and correction of analysis condition such as a predictive period, a trigger condition, and so on, and the associated information, for example. The operator requirement receiving process unit **151** receives the operational manipulation (or cope manipulation) by the operator, for example. An example of the operational manipulation will be described later. The operator requirement receiving process unit **151** outputs the associated information to the associated information receiving process unit **160**, outputs the operational manipulation, and so on to the cope history process unit **182**, and outputs the observation item to the knowledge addition/correction process unit **141**, for example.

The cope history process unit **182** receives the operational manipulation, and registers the history in the knowledge DB **140** when the history is stored as the coping method, for example. For example, when the O&M system **100** estimates the cause event, the cope history process unit **182** can register how the operator coped with the cause event in the knowledge DB **140** as operational manipulation history (cope history, operational manipulation, or the like).

The display editing unit **184** generates a graphic format of the cause event output from the cause event determining process unit **131** or the output from the statistical analysis process unit **180**, or converts a tabular format, in accordance with requirement of the operator requirement receiving process unit **151**, for example. The display editing unit **184** outputs the converted cause event and so on to the monitor **186**. The requirement of the operator requirement receiving process unit **151** includes a display section, a display format, and so on, for example.

The monitor **186** can display the output from the display editing unit **184**, for example.

<Example of Entire Operation of O&M System **100**>

Next, an example of the entire operation of the O&M system **100** will be described. FIG. **5** is a flowchart illustrating the example of the entire operation of the O&M system **100**. The detail of the estimating process or the narrowing process cause will be described later. Herein, the example of the entire operation of the O&M system **100** will be described.

When the O&M system **100** starts the process (S**10**), the O&M system **100** performs extracting or narrowing process of the observation event deemed as state event change, based on the observation event (S**11**).

For example, the present process is performed in such a manner that the observation event extracting unit **121** performs the narrowing process with respect to the observation event received from the observation event receiving process unit **111**. The detail of the narrowing process will be described below, referring to FIGS. **26** to **29**. It is noted that the extracting process for the distinctive factor performed in the observation event analyzing process unit **122** may be performed in the course of the present process.

Next, the O&M system **100** estimates the cause event (S**12**). For example, the cause event determining process unit **131** estimates the cause event based on the distinctive factor output from the observation event analyzing process unit **122**. The detail of the estimating process of the cause event will be described below, referring to FIGS. **11** to **23**.

Next, the O&M system **100** determines whether the estimated cause event is an event defined by the knowledge DB **140** or not (S**13**). This process is to notify the operator of what the estimated cause event is obtained comparison with the cause event obtained in the past, for example. For example, the cause event determining process unit **131** can access the knowledge DB **140** via the knowledge registering process unit **142** and determine whether the cause event identical with or similar to the estimated cause event is registered in the knowledge DB **140** or not.

When the estimated cause event is the event defined by the knowledge DB **140** (S**13**, YES), the O&M system **100** notifies the operator of the estimated cause event (S**14**).

For example, when the cause event determining process unit **131** confirms that the cause event identical with or similar to the estimated cause event is registered in the knowledge DB **140**, the cause event determining process unit **131** displays the estimated cause event on the monitor **186** via the display editing unit **184**.

The O&M system **100** ends process (S**15**).

On the other hand, when the estimated cause event is not the event defined by the knowledge DB **140** (S**13**, NO), the O&M system **100** registers the estimated cause event in the knowledge DB **140** (S**16**). For example, the cause event determining process unit **131** outputs the estimated cause event to the statistical analysis process unit **180** and registers the estimated cause event in the knowledge DB **140** via the statistical analysis process unit **180** and the knowledge addition/correction process unit **141**.

Next, the O&M system **100** registers in the knowledge DB **140** content that the estimated cause event is not the event defined by the knowledge DB **140**, and notifies the estimated cause event to the operator (S**14**).

In addition, the O&M system **100** ends process (S**15**).

Now, the example of the entire operation of the O&M system **100** is described above. In view of the whole flow, the O&M system **100** performs the narrowing process from the observation event (S**11**), and further performs the estimating process of the cause event with respect to the narrowed observation event (S**12**).

<Description of Implementation Model>

Next, the implementation model to implement the estimation of the cause event and the estimating method of the cause event will be described.

FIG. **6** is a diagram illustrating an example of the observation model in the O&M system **100** and illustrating an example of relation between the observation event and the cause event.

For example, as illustrated in FIG. **6**, when the event to be observed (=observation event) is represented as “Y”, and a space in which the observation events Y can exist is logically represented as (−∞, ∞). The space in which the observation events Y can actually exist can be represented as finite closed space.

For example, in the information communication network system **10** (for example, FIG. **2**), the base station can observe various observation data such as “transmission power increase” and so on as the observation event. However, the observation event that the base station can actually observe is a part of the entire observation event. Accordingly, the space in which the observation events Y can actually exist is represented as the finite closed space.

In addition, when the event not to be observed (or the cause event to be estimated) is represented as “X”, the event X not to be observed is illustrated FIG. **6** for example, as an event inherent in the observation event Y.

For example, a case will be assumed where the observation event Y such as “transmission power increase”, “traffic is high in a self cell”, and so on are obtained in the base station, and the corresponding cause events X is “loads are concentrating” and “there exists an error in the setting parameter”. In this case, the cause event X such as “loads are concentrating” and so on can be represented as the event inherent in the observation event Y (such as “transmission power increase”, “traffic is high in a self cell”, and so on). Accordingly, the observation model can be exemplified as illustrated in FIG. **6**.

In the observation model illustrated in FIG. **6**, when the observation event Y is regarded as a response variable, the event X not to be observed is regarded as an explanatory variable. In the observation model, the O&M system **100** estimates the event X not to be observed with respect to the observation event Y.

FIG. **7** is a diagram illustrating an example of the system model regarding the cause event X and the observation event Y.

In the case where the observation event observed at a time t is “Yt”, and the state to be estimated at the time t is “Xt”, the observation event Yt can be represented in the following formula (1).

$$Yt=Ht\cdot Xt+wt \tag{1}$$

Here, Ht represents a transfer function, and wt represents observation noise. Xt includes a k-dimensional variable, Yt includes i-dimensional variable, and Ht represents a (i×k) determinant.

Next, when the state Xt at the time t is dependently affected by a state Xt−1 at a time (t−1), the state Xt can be represented in the following formula (2).

$$Xt=Ft\cdot Xt-1+Gt\cdot vt \tag{2}$$

Here, Ft and Gt represent a transfer function, vt represents a desired value.

As described above, when the formula (1) is considered to be a time-series model representing the mechanism of the observation value yt, Xt represents a coefficient, and the formula (2) represents an expression model of temporal change of the coefficient Xt.

As illustrated in FIG. **6**, it is conceivable that the cause event X is the event inherent in the observation event Y. In this case, the problem of estimating the cause event X from the observation event Y can be replaced with the problem of estimating the state Xt={x1, x2 . . . xt} at a time t (note; j>t) from the observation event Yj={y1, y2, . . . yj}.

That is, the problem of estimating the cause event X from the observation event Y arrives at the problem of calculating a conditional probability P (Xt|Yj) calculating past states {x1, x2, . . . xt} based on the observation values {y1, y2, . . . yj} up to the time t (or the present time), for example.

FIG. **8** is a diagram illustrating an example of the model of temporal change representing the relation between the observation event Y and the cause event X. For example, the observation value yt is brought by the cause event Xt (actual state θt in FIG. **8**), and the O&M system **100** estimates the cause event Xt from the observation value yt.

However, there is a case where the estimated cause event Xt (estimated state θ't in FIG. **8**) corresponds to the original cause event Xt (estimated state θt in FIG. **8**), or there is a case where the estimated cause event Xt does not completely correspond to the original cause event Xt.

FIG. **9**A is a diagram illustrating an example of time displacement of the observation event Y, and FIG. **9**B is a diagram illustrating an example of time displacement of the cause event X. The observation event Y (observation value in FIG. **9**A) actually changes as the time goes by, and the value is put within a range of normal distribution at each time.

For example, regarding the observation event of "transmission power increase", transmission power value shifts within a certain constant range, and the observation event of "transmission power increase" is obtained in the constant range.

Similarly, the cause event X changes as the time goes by, and the value is put within a range of the normal distribution at each time.

For example, regarding the cause event of "radio resource is running out", the event shifts within a certain constant range regarding to what extent the radio resource is running out, and the cause event of "radio resource is running out" is obtained in the constant range.

Based on the observation model and the system model described above, the implementation model to estimate the cause event can be constructed. FIG. **10** is a diagram illustrating an example of the implementation model to estimate the cause event.

The cause event θt inherent in the observation event Y changes as the time goes by (S**20**). The observation event Yt occurs due to the cause event et, and O&M system **100** observes the observation event Yt (S**21**).

In this case, for example, the O&M system **100** stores in a memory the observed (or collected) observation event Yt as a DB (for example, knowledge DB **140**) (S**22**).

The O&M system **100** read out the observation event from the DB, and estimates the cause event Xt (estimated state θ't in FIG. **10**) from the observation event Yt (S**23**).

In addition, for example, the O&M system **100** estimates the present cause event Xt from the cause event X (t−1) (estimated state θ't−1 in FIG. **10**) estimated in the past time (time t−1) and the cause event Xt (estimated state θ't in FIG. **10**) estimated in the present time (time t) (S**24**).

The implementation model illustrated in FIG. **10** can be implemented in the O&M system **100** illustrated in FIG. **4**, for example. In this case, the estimation of the cause event X (S**24** and S**24**) can be implemented in the observation event extracting unit **121**, the observation event analyzing process unit **122**, and the cause event determining process unit **131** in the O&M system **100** (for example, in FIG. **4**), for example.

<Detailed Example of Operation>

Next, the example of the operation of the O&M system **100** will be described. As for the example of the operation, in order to facilitate easy understanding of the operation, the description will be made according to the following item and orders.

<1. Estimating method of cause event>

<2. Example of observation event and example of cause event>

<3. Example of process in the O&M System **100**>

<4. Example of process in case where observation event is "connection ratio reduction">

<5. Example of estimating process of cause event>

<5.1 Example of estimating process of cause event in tabular format>

<5.2 Example of estimating process of cause event in decision format>

<6. Example of coping method>

<7. Example of other operation>

First, the estimating method of the cause event will be described referring to FIG. **11** (<1. Estimating method of cause event>). Second, the example of the observation event and the example of the cause event will be described referring to FIG. **12** (<2. Example of observation event and example of cause event>). Thirdly, the specific example of process in the O&M system **100** will be described referring to FIGS. **13** and **16** (<3. Example of processes in the O&M System **100**> and <4. Example of process in case where observation event is "connection ratio reduction">). Fourthly, the example of the estimating process of the cause event will be described referring to FIGS. **18** and **19** (<5. Example of estimating process of cause event>). Fifthly, the example of the coping method will be described referring to FIG. **21** (<6. Example of coping method>). Lastly, the example of other operations will be described referring to FIGS. **22** and **23** (<7. Example of other operation>).

<1. Estimating Method of Cause Event>

FIG. **11** is a flowchart illustrating an example of the estimating method of the cause event. The example of the flowchart illustrated in FIG. **11** corresponds to a flowchart representing the detailed example in S**12**, out of the examples of the entire operation (for example, FIG. **5**) of the O&M system **100**, for example.

In the flowchart illustrated in FIG. **11**, {y1, y2, y3} represents the observation events, and {θ1, θ2, θ3} represents the cause events to be estimated (occurrence event in FIG. **11**).

When the O&M system **100** starts the process (S**30**), the O&M system **100** performs conditional determination (S**31** to S**33**) and obtains each cause event {θ1, θ2, θ3} with respect to the observation events {y1, y2, y3}.

For example, the O&M system **100** determines whether an observation event y1 meets a condition (y1≤m) or not (S**31**). When the observation event y1 meets the condition, the O&M system **100** determines whether an observation event y2 meets a condition (y2≤n) or not (S**32**). The O&M system **100** performs the conditional determination with respect to all the observation events {y1, y2, y3, . . . } (or part of the observation events) and obtains the cause events {θ1, θ2, θ3, . . . }.

For example, the example of the flowchart illustrated in FIG. **11** represents the example of the estimating process of the cause event in a decision format, for example, and it is described below based on the specific example in the section "<5.2 Example of estimating process of cause event in decision format>".

<2. Example of Observation Event and Example of Cause Event>

A table illustrated in FIG. **12** represents an example of the observation event collected by the O&M system **100**. FIG. **12** represents the example of the observation event, in which "self cell traffic" is "high", and "another cell traffic" is "low", and "Call Drop (call disconnection)" is "low", and "another cell radio link-failure (RL-F)" is "high".

An expedient expression such as "high" and "low" is used in the table, however, a specific numerical value may be applied in place of the expression such as "high" and "low". For example, the O&M system **100** may collect the numerical value regarding the observation event observed in the base station, and so on, compare the numerical value with threshold value, and obtain the observation result such as "high" and "low". Or, the O&M system **100** may compare the specific value observed in the base station with the threshold value in the base station, and obtain the observation result such as "high" and "low" by collecting the comparison result from the base station.

There is "load in a self-cell is higher than a threshold value, and quality is not satisfactory on uplink side, so that "reject" occurs", as specific event (or observation event) illustrated in FIG. **12**, for example. The occurrence of this event leads to acquisition of the observation event illustrated in FIG. **12**.

In the case illustrated in FIG. **12**, the cause of the occurrence of the observation event is as follows, for example.

1) Excessive load occurs.

2) Handover area is larger than threshold value.

3) Excessive radio wave is received from the terminal **200** located in the area of the another cell (or another base station).

4) There exists an error in the setting of the various system parameter.

5) Others.

1) to 5) are likely to lead to the cause event with respect to the observation event illustrated in FIG. **12**. The cause event is a single cause or a plurality of causes described above, for example. The O&M system **100** performs the estimating process of the cause event, thereby estimating 1) to 5) as the cause event with respect to the observation event illustrated in FIG. **12**.

In the example of the operation described later, the concrete example of the observation event and the cause event are described. These examples will be described on each occasion.

<3. Example of Processes in the O&M System **100**>

FIG. **13** is a diagram illustrating an example of processes in the O&M system **100**. The diagram illustrated in FIG. **13** represents the example of the entire process of the O&M system **100**, for example. In FIG. **13**, the same reference numeral is designated to the process same as the process illustrated in FIGS. **5** and **11**.

For example, when the O&M system **100** obtains the observation events B, C, and D, the O&M system **100** performs the conditional determination (S**30** to S**33**) and analyzes the observation events B, C, and D. For example, the conditional determination can be performed in the observation event analyzing process unit **122** (for example, FIG. **4**).

Based on the conditional determination, the O&M system **100** determines the cause event (S**12**). For example, the determination of the cause event can be performed in the cause event determining process unit **131** (for example, FIG. **4**).

In addition, the O&M system **100** determines whether the cause event is registered in the knowledge DB **140** or not (S**13**). When the cause event is registered in the knowledge DB **140**, the O&M system **100** notifies the cause event to the operator (S**14**). In this case, the O&M system **100** determines the coping method indicating how the estimated cause event is coped with, thereby providing the operator with determined the coping method (S**35**). For example, determination and provision of the coping method can be performed by the cause event determining process unit **131** and the knowledge registering process unit **142**.

For example, data indicating the coping method is registered in the knowledge DB **140**, and the O&M system **100** reads out the data indicating coping method from the knowledge DB **140** and outputs the data to the monitor **186**, thereby providing the coping method for the operator or surveillant. Hereinafter, this operation in the O&M system **100** is referred to as "an operation in which the O&M system **100** provides the coping method", and the coping method and the data indicating coping method may be merely referred to as "coping method" not so as to be distinguished, for example.

On the other hand, the O&M system **100** extracts the distinctive factor from the time-series displacement with regards to the observation event and cause event, and registers the distinctive factor in the knowledge DB **140** (S**16**).

The observation events B, C, and D may be considered to be obtained from three base station (cell, or the like) or the observation events B, C, and D may be considered to be obtained from two base stations or more.

Regarding the observation event, the distinct coping method can be provided for some observation event. For example, when the conditional determination is fulfilled for the observation event A, the O&M system **100** determines the coping method without estimating the cause event with respect to the observation event A, and provides the coping method for the operator (S**36**). The observation event A is limited to certain one base station (or cell), and another base station (or cell) is not affected by the observation event A, for example.

For example, when concert is held in a certain area, there is a case where "Call Drop ratio" as the observation event changes only in the area. In this case, the O&M system **100** can affirmatively provide the coping method (for example, call is limited).

FIG. **14** illustrates an example of the observation events. FIG. **14** illustrates the example in which the observation event is classified into "classification" and "apparatus, location, and so on to be observed". For example, "classification" is exemplified by "quality state" and "call connection state". For example, there is "UP LINK" and "Adaptive Multi Rate (AMR) as an example of "apparatus to be observed, observation location, or the like. For example, the observation event can be classified by "quality state" and "UP LINK".

Such classification regarding the observation event is one example, and other classifying method may be applied. However, the operation of the O&M system **100** is not affected by the difference between the classifying method of the observation event.

<4. Example of Process in Case where Observation Event is "Connection Ratio Reduction">

Next, the specific example of processes will be described based on the example of "connection ratio reduction" as the observation event. FIG. **15** is a flowchart illustrating the example of the case where the observation event is "connection ratio reduction".

There is "Radio Resource Control (RRC) connection ration reduction" indicating the connection ratio of the mobile information terminal **200** to the base station on an RRC protocol level, "Multi RAB connection ration reduction" indicating the connection ratio of the mobile information terminal **200** in radio bearer to the base station, and so on, as the example of the observation event regarding "connection ratio reduction", for example.

For example, "connection ratio reduction" in the radio communication system is actually such that several hundreds of the observation events are integrated and represented as "connection ratio reduction". FIG. **16** illustrates an example of each observation event as "connection ratio reduction".

For example, the O&M system **100** can obtain the observation event regarding the connection ratio reduction from the base station and so on, and when obtains the observation event, the O&M system **100** performs the conditional determination illustrated in FIG. **15** (S**41** to S**47**) and estimates the cause event (S**50** and S**52**).

For example, as to the process of determining the cause event, the O&M system **100** holds information on what order to determine the observation event or holds the flowchart itself illustrated in FIG. **15**. And, the O&M system **100** performs the conditional determination in accordance with the order of the obtained observation event or in accordance with the flowchart illustrated in FIG. **15** (S**41** to S**47**), and estimates the cause event (S**50** and S**52**), for example.

Similarly, the O&M system **100** holds the cause event and coping scenario illustrated in FIG. **15** in the memory and so on (for example, the knowledge DB **140**), and the O&M system **100** can estimate the cause event (S**50** and S**52**) and determines the coping scenario (S**51** and S**53**).

For example, when the cause event is identified, the coping method is also identified. Accordingly, in the example in FIG. **15**, the coping method is "coping scenario A" when the cause event is "observation analysis A" (S**50** and S**51**), and the coping method is "coping scenario B" when the cause event is "observation analysis B" (S**50** and S**53**).

In FIG. **15**, for example, the processes from S**41** to S**47** can be carried out by the observation event analyzing process unit **122**, and the process in S**50** and S**52** can be performed by the cause event determining process unit **131**, and the processes in S**51** and S**53** can be performed by the knowledge registering process unit **142** and the cause event determining process unit **131**.

Of these processes, the presentation of the coping method (S**51** and S**53**) can be executed in a manner that the cause event determining process unit **131** accesses the knowledge DB **140** via the knowledge registering process unit **142** and reads out the coping method corresponding to the cause event from the knowledge DB **140**.

<5. Example of Estimating Process of Cause Event>

An example of the estimating process of the cause event is described, for example, referring to FIG. **15**, however, another estimating process will be described together with the example of the estimating process of the cause event in this section.

<5.1 Example of Estimating Process of Cause Event in Tabular Format>

There is an example of the estimating process by a table (or tabular) format as the example of the estimating process of the cause event includes, for example. FIG. **18** illustrates an example of the table applied in the O&M system **100**, and FIG. **17** illustrates an example of the cause event.

In FIG. **18**, "self cell traffic", "another cell traffic", "Call Drop", and "another cell RL-F" represent the item of the observation event, for example. In addition, "analysis result No" represents a corresponding cause event number, for example. In the table illustrated in FIG. **18**, a specific number of the "analysis result No" is obtained based on the combination of the observation result (or observation event) such as "high", "low", or the like in the items of the observation event.

For example, when "self cell traffic", "another cell traffic", "Call Drop", and "another cell RL-F" are "high", "high", "low", and "high" respectively, "11" is selected as "analysis result No". Further, when "self cell traffic", "another cell traffic", "Call Drop", and "another cell RL-F" are "high", "low", "low", and "high" respectively, "13" is selected as "analysis result No".

For example, when "analysis result No" is "11", the cause event corresponds to "load is concentrating" illustrated in FIG. **17**, and when "analysis result No" is "13", the cause event corresponds to "interference waves exist".

Accordingly, the O&M system **100** holds the table illustrated in FIG. **18** and information associated with the cause event illustrated in FIG. **17** in the memory (for example, the knowledge DB **140**) and obtains "analysis result No" with respect to the observation event obtained from the table. And, the O&M system **100** reads out the cause event corresponding to "analysis result No" so as to estimate the cause event. For example, "analysis result No" and the cause event are held in the memory, and "analysis result No" and the cause event are correspondingly held, thereby the O&M system **100** can identify the cause event based on "analysis result No".

The table illustrated in FIG. **17** and the cause event illustrated in FIG. **18** are one example, and another table can be applied for the execution. Further, one or more of the cause event may be identified from "analysis result No" as the cause event. For example, "analysis result No" is stored in the memory in such a manner that a plurality of the cause events corresponds to "analysis result No", and when a one of "analysis result No" is obtained, the plurality of cause events can be identified.

In the example of the cause event illustrated in FIG. **17**, the cause event can be classified into "classification" and "apparatus, location, and so on to bring about the cause". For example, there is "threshold value is too low or high" as the cause event regarding "handover". This classification is one example, and the estimating process of the cause event is not affected by the difference in the classifications.

FIGS. **19**A and **19**B illustrate the examples of a table. In examples illustrated in FIGS. **19**A and **19**B, there are "self cell traffic", "another cell traffic", and "Hand Over (HO) ratio" as the items of the observation, and "condition" ("analysis result No" in the example of FIG. **18**) is selected in accordance with these observation results. Similar to the example illustrated in FIG. **18**, one or more corresponding cause events are selected in accordance with the selected condition.

<5.2 Example of Estimating Process of Cause Event in Decision Format>

FIG. **20** is a flowchart illustrating an example of the estimating process of the cause event. The estimating process of the cause event based on a decision format is an estimating process of the cause event by the flowchart illustrated in FIG. **20**, for example. For example, FIGS. **11** and **15** illustrate examples of the estimating process of the cause event by the decision format.

In FIG. **20**, there are "Resource" regarding radio resource applied for radio communication between the base station and the mobile information terminal **200**, "TX power" and "RX power" regarding transmission power and reception power of the base station, and so on as the item of the observation event.

For example, the O&M system **100** determines whether "Resource shortage" of the observation event is obtained or not (S**61**), when the value of "Resource" obtained from the base station is lower than a threshold value. In addition, the O&M system **100** determines whether "TX power reaches the limits" of the observation event is obtained or not (S62), when the value of "TX power" obtained from the base station is interposed between the threshold value and a limited value. The O&M system **100** performs these determinations with respect to the observation events one by one (S**61** to S**64**), thereby estimates the cause event.

For example, in a case where there occurs a traffic state having a value higher than the threshold value, and there exists an area (or cell, or base station) that does not satisfy Quality of Service/Grade of Service (QoS/GoS), the observation events described above are obtained. FIG. **20** illustrates the example of the estimating process of the cause event in the case above.

In the example illustrated in FIG. **20**, for example, the O&M system **100** holds the order of determinations of the observation events in the memory and so on, and determines the obtained observation event one by one in accordance with the order, thereby estimates the cause event.

In FIG. **20**, the determination of the cause event is omitted, however, the determination of the cause event is actually performed prior to the coping scenario (S**65**, S**66**, and S**67**).

There are "instrument failure (replacement)" (S**65**), "(access) parameter adjustment" (S**66**), "(HO) parameter adjustment, and so on" (S**67**), and so on as the example of the coping scenario (or coping method).

For example, "instrument failure (replacement)" represents the coping scenario indicating that failure occurs in instrument of the base station, and the instrument needs to be replaced. In addition, "(access) parameter adjustment" represents the coping scenario indicating that parameters applied for the radio communication between the base station and the mobile information terminal **200** is adjusted, for example. Further, "(HO) parameter adjustment and so on" represents the coping scenario indicating that parameter used in the base station is adjusted in handover of the mobile information terminal **200**.

When the O&M system **100** estimate the cause event, the O&M system **100** selects the coping scenario described above and notifies the coping scenario to the operator. Accordingly, the O&M system **100** can notify to the operator and so on what cope can be applied to the information communication network system **10** and can support the operator in the decision-making.

The coping scenario illustrated in FIG. **20** represent the example in which one coping scenario corresponds to one cause event. Alternatively, two coping scenarios or more may be selected for one cause event.

<6. Example of Coping Method>

Next, the concrete example of the coping method (or coping scenario) will be described. FIG. **21** is a diagram illustrating example of the observation event, the cause event, and the coping method in the tabular format.

In the example illustrated in FIG. **21**, two observation events are represented. That is, the example of the observation event is represented on the left side of FIG. **21**, and the example of the observation event is represented on the right side of FIG. **21**. The example of the observation event represented on the left side of FIG. **21** is an example in which the self cell traffic is "high", the another cell traffic is "high", and Call Drop ratio is "low". The example of the observation event represented on the right side of FIG. **21** is an example in which the self cell traffic is "high", the another cell traffic is "high", and Call Drop ratio is "high".

The difference between the two observation events lies in Call Drop ratio. As illustrated in FIG. **21**, the event obtained from the two observation events is intensively represented as "self and another cells both have substantial loads, and the quality on UL side is not satisfactory, and Reject occurs.", which gives the expression that the difference between the observation events is not clear.

In this case, the O&M system **100** can estimate the cause events such as "parameter setting error", "HO area is too wide", "excessive radio waves are received from a another cell", "TX-system apparatus failure", "overload", and so on, with respect to the two observation events. These estimated cause events each serve as the same cause event with respect to the two observation events.

However, in response to the slight difference between observation events (difference in "Call Drop ratio" in the example of FIG. **21**), the O&M system **100** can provide a different coping method. In the example of FIG. **21**, the O&M system **100** provides the coping method including "Admission threshold value is raised" with respect to the observation event illustrated on the left side of the diagram and provides the coping method not including "Admission threshold value is raised" with respect to the observation event illustrated on the right side of the diagram.

Thus, the O&M system **100** can provide different coping methods in accordance with the slight difference between observation events. Accordingly, compared with the case where the coping methods are identical, the O&M system **100** can enhance accuracy in term of the provided coping method.

For example, the O&M system **100** holds the coping method in the memory (for example, the knowledge DB **140**) and so on, reads out the coping method from the memory in accordance with the observation event, and outputs the coping method to the monitor **186** and so on, thereby provides the coping method for the operator.

The O&M system **100** stores the coping method as coping history in the knowledge DB **140**. For example, the history is stored in the knowledge DB **140** in such ways that the observation event is improved as the result of cope by a certain coping method with respect to a certain cause event, or that the observation event does not be improved as the result of cope by another coping method. For example, the knowledge DB **140** can stores what improvement the O&M system **100** is achieved, by means of manipulation of the operator to the O&M system **100**. In addition, the O&M system **100** can perform the process of providing the improved coping method, based on the history stored in the knowledge DB **140**.

According to the presentation of the coping method, or the presentation of the coping method to be improved, the O&M system **100** can support the operator in decision-making with regard to the coping method and improvement measure to the information communication network system **10**.

<7. Examples of Other Operation>

Next, an example of the other operation will be described. The example described above (for example, FIG. **15**) includes the example of "connection ratio reduction" as the example of the observation event.

FIG. **22** illustrates an example of the estimating process of the cause event in a case where "Call Drop ratio increase" and "handover success ratio reduction" are exemplified as the observation event. The subject of the observation event is changed from "connection ratio reduction" to "Call Drop ratio increase" and "handover success ratio reduction", and the estimating processes of the cause event (S**80** to S**86** and S**90** to S**96**) are carried out with respect to each observed observation event.

FIG. **22** illustrates the example of the estimating process of the cause event in the decision format. Alternatively, similar to FIG. **18**, the cause event may be estimated based on the tabular format. In this case, for example, in the item of the observation event in FIG. **18**, the observation events regarding "Call Drop ratio increase" and "handover success ratio reduction" ("entire Call Drop ratio increase" or "hard HO success ratio reduction" and so on) are stored. Similar to the example described above, the O&M system **100** selects "analysis result No" and identifies the cause event corresponding to "analysis result No" from the combination of the observation events, thereby estimates the cause event.

FIG. **23** is a diagram illustrating the specific example of the observation event regarding "Call Drop ratio increase" and "handover success ratio reduction".

For example, there are "total call drop ratio increase of Circuit Switching (CS)" representing the call drop ratio increase of the entire circuit switching call, "total call drop ratio increase of Packet Switching (PS)" representing the call drop ratio increase of the entire packet call, and so on, as "Call Drop ratio increase".

For example, there are "success ratio reduction in the preparation phase of Hard Hand Over (HHO)", "success ratio reduction in the execution phase of HHO" respectively representing the success ratio reduction in the preparation phase and execution phase of handover, and so on, as "handover success ratio reduction".

The O&M system **100** estimates the cause event in the decision format (for example, FIG. **22**) or the tabular format (for example, FIG. **18**) based on such observation event.

<Detailed Example of Entire Operation of the O&M System **100**>

Next, the detailed example of the operation of the O&M system **100** will be described. The example of the operation of the O&M system **100** is described in the section <Example of entire operation of the O&M System **100**> described above. In this section, the detailed example of the operation of the O&M system **100** will be described. The same description will be partially made. However, the examples of the operation will be described en masse in this section.

FIGS. **24** and **25** are flowcharts illustrating the detailed example of the operation of the O&M system **100**. In order to facilitate easy understanding, the flowcharts in FIGS. **24** and **25** include the configuration in the O&M system **100**.

In FIG. **24**, the O&M system **100** further includes an operation information reception process unit **161**, an operation environment analyzing process unit **163**, an observation subject system interface process unit **112**, an observation event extracting process unit **123**, a process subject observation event extracting process unit **124**, a change state event detecting process unit **125**, and an extract observation event renewal process unit **166**.

Incidentally, the operation information reception process unit **161** and the operation environment analyzing process unit **163** correspond to the associated information receiving process unit **160** in the O&M system **100**, illustrated in FIG. **4**, for example. In addition, the observation subject system interface process unit **112** corresponds to the observation event receiving process unit **111** in the O&M system **100** illustrated in FIG. **4**, for example.

In addition, the observation event extracting process unit **123** and the process subject observation event extracting process unit **124** correspond to the observation event extracting unit **121** in the O&M system **100** illustrated in FIG. **4**, for example. Further, the change state event detecting process unit **125** corresponds to the observation event analyzing process unit **122** in the O&M system **100** illustrated in FIG. **4**, for example. Further, the extract observation event renewal process unit **166** corresponds to the statistical analysis process unit **180** in the O&M system **100** illustrated in FIG. **4**, for example.

In FIG. **24**, the O&M system **100** further includes an operation information DB **162**, an operation environment condition DB **164**, an observation event DB **113**, an extract observation event DB (t-time part) **167**, an extract observation event DB (t−1 time part) **165**, a process subject observation event DB **127**, and a change state event DB **128**. These DBs illustrated in FIG. **24** are stored in a memory such as a hard disk in the O&M system **100**, for example.

The processes in FIG. **24** include a process of setting an environment condition to perform a screening with respect to the observation event (S**101** to S**104**), a process of extracting the observation event that serves as a subject to be processed, by the screening the observation event based on the set environment conditions (S**105** to S**116**), and a process of renewing the observation event (S**117** to S**119**), for example.

First, the process of setting the environment condition (S**101** to S**104**) will be described. The operator IF process unit **150** receives operation associated information including the event information and cell information (or associated information, and hereinafter, the associated information may be referred to as operation associated information) (S**101**).

The operation associated information includes the entertainment information, the cell information, and so on, for example. The event information includes information on date, place at which concerts or sport competitions are held, and so on, for example. The cell information includes information in which a certain base station is out of order, temporarily halted, or the like, for example. The event information and the cell information include regional condition, temporal condition such as date, times, season, and so on, condition such as meteorological feature, the operational state of the base station, or the like as described above, for example. For example, the operation associated information is input by the operator operating the O&M system **100** and so on.

When the operation information reception process unit **161** receives the operation associated information, the operation information reception process unit **161** stores the operation associated information in the operation information DB **162** (S**102**).

Next, the operation environment analyzing process unit **163** reads out the operation associated information from the operation information DB **162** and analyzes the operation associated information (S**103**). For example, the operation environment analyzing process unit **163** confirms what information the operation associated information includes, what condition the condition described above include, or the like. The operation environment analyzing process unit **163** stores the analyzed operation associated information in the operation environment condition DB **164** as the operation condition (S**104**), for example.

As described above, the operation condition is registered in the operation environment condition DB **164**, and the O&M system **100** can perform the screening with respect to the observation event based on the registered operation condition.

Next, the process of the screening (S**105** to S**116**) will be described. The observation subject system interface process unit **112** receives the observation event (S**105**). The observation events include several hundreds of types of the observation events (for example, "events to be observed" illustrated in FIG. **14**), for example.

Next, the observation event receiving process unit **111** receives the observation event from the observation subject system interface process unit **112** and stores the received observation event in the observation event DB **113** (S**106**).

Next, the observation event extracting process unit **123** performs the screening (or filtering) with respect to the observation event read out from the observation event DB **113** based on the operation condition read out from the operation environment condition DB **164** (S**107** and S**108**).

For example, the observation event extracting process unit **123** performs the process of removing the observation event that is clearly not considered as a subject based on the operational condition. For example, in a case where the event is held in a certain area, and the observation event indicating that the traffic is excessively high in the base station that covers the area is obtained, the observation event extracting process unit **123** determines that the observed observation event is not considered as a subject. In other case where a certain base station is halted, and the observation event indicating that HO ratio represents an excessively high value in the adjacent base station is obtained, the observation event extracting process unit **123** determines that the observed observation event is not considered as the subject.

For example, the observation event extracting process unit **123** performs the screening in such a manner as to remove the observation event, which is not considered as the subject, from the observed subject. The observation event extracting process unit **123** can perform the screening, for example, by extracting the observation event corresponding to the operation condition. The observation event extracting process unit **123** stores the screened observation event in the extract observation event DB (t-time part) **167** (S**109**).

Next, the process subject observation event extracting process unit **124** performs the screening (or filtering) of the observation event to be processed, based on the latest observation event (time t) read out from the extract observation event DB (t-time part) **167** and the previous observation event (time t−1) read out from the extract observation event DB (t−1 time part) **165** (S**110** and S**111**).

For example, the process subject observation event extracting process unit **124** performs the screening in a manner as to extract the observation event in which temporal change (or time-series change) occurs. The process subject observation event extracting process unit **124** extracts the observation event having the significance as the subject to be processed, for example.

The observation event extracting process unit **123** described above performs primary screening in a manner as to remove the observation event that is obviously considered not to be the subject, for example. The process subject observation event extracting process unit **124** performs secondary screening for the observation event after the primary screening, in a manner as to extract the observation event needed for time-series analysis, for example. For example, the process of extracting the observation event to be processed from several hundreds of the observation events is performed by the observation event extracting process unit **123** and the process subject observation event extracting process unit **124**.

Further, the observation event extracting process unit **123** or the process subject observation event extracting process unit **124** can receive the result of the narrowing process performed in the knowledge registering process unit **142** (for example, the observation event to be observed) and extract the observation event, for example. The detail of the process will be described below.

The process subject observation event extracting process unit **124** stores the extracted observation event in the process subject observation event DB **127** (S**112**).

Next, the change state event detecting process unit **125** detects the observation event to be recognized as the state event change with respect to the observation events read out from the process subject observation event DB **127**, based on the past observation event read out from the knowledge DB **140** (S**113** and S**114**).

For example, the change state event detecting process unit **125** reads out the observation event identical to the observation event to be processed from the knowledge DB **140**, and when the observation event to be processed is different from the observation event read out from the knowledge DB **140**, the change state event detecting process unit **125** can detect that the observation event to be processed is the observation event in which the state event is changed.

The change state event detecting process unit **125** stores the detected observation event in the change state event DB **128** (S**115**). The subsequent process is illustrated in FIG. **25**.

Next, the renewing process of the detected observation event (S**117** to S**119**) will be described. The extract observation event renewal process unit **166** performs the renewing process of the extracted observation event. That is, the extract observation event renewal process unit **166** reads out the latest observation event (t time) read out from the extract observation event DB (t-time part) **167** and the previous observation event (time t−1) read out from the extract observation event DB (t−1 time part) **165** (S**117** and S**118**), for example. In addition, the extract observation event renewal process unit **166** updates the previous observation event read out, into the latest observation event and stores the latest observation event in the extract observation event DB (t-time part) **167** (S**119**).

The extract observation event renewal process unit **166** operates independently of the extracting process of the state change event and the determining process of the cause event (for example, FIG. **25**) and ends the processes before receiving the observation event in the next circle, for example.

FIG. **25** is a flowchart illustrating the detailed example of the operation of the O&M system **100**, leading from FIG. **24**. In order to facilitate easy understanding, the flowchart in FIG. **25** represents a part of the configurations included in the O&M system **100**.

Further, the O&M system **100** includes a knowledge information reception process unit **152**, a knowledge renewal process unit **144**, a cause determining process unit **132**, a cause notifying process unit **133**, an operator-or-external-output-apparatus interface unit **169**, a cause analyzing process unit **168**, an operation history reception process unit **170**, and an operation history analyzing process unit **172**.

Specifically, the knowledge information reception process unit **152** corresponds to the operator requirement receiving process unit **151** illustrated in FIG. **4**, for example. The knowledge renewal process unit **144** corresponds to the knowledge addition/correction process unit **141** and the knowledge registering process unit **142**, for example. Further, the cause determining process unit **132** corresponds to the cause event determining process unit **131** illustrated in FIG. **4**, for example. Further, the cause notifying process unit **133** and the operator-or-external-output-apparatus interface unit **169** correspond to the display editing unit **184** illustrated in FIG. **4**, for example. Further, the cause analyzing process unit **168** corresponds to the cope history process unit **182** illustrated in FIG. **4**, for example. Further, the operation history reception process unit **170** and the operation history analyzing process unit **172** correspond to the operator requirement receiving process unit **151** illustrated in FIG. **4**, for example.

Further, the O&M system **100** includes a knowledge information DB **153**, a state event change cause DB **134**, a notice log DB **135**, an operation history DB **171**, and a history analyzing DB **173**. For example, these DBs illustrated in FIG. **25** can be stored in the memory such as a hard disk and so on in the O&M system **100**.

The processes in FIG. **25** include a registering process of adding new item or deleting the item to/in the knowledge DB **140** (S**125** to S**129**), an estimating process of the cause event (S**130** to S**132**), and a registering process of the operations of the operator in the knowledge DB **140** (S**140** to S**147**), for example.

First, the registering process for the knowledge DB **140** (S**125** to S**129**) will be described. The operator IF process unit **150** receives the knowledge information (S**125**). The knowledge information includes the observation event (observation items) stored in the knowledge DB **140** and the determination condition such as a threshold value in a case where the self-cell traffic is determined "high" with respect to the observation event, for example. In addition, the knowledge information includes a table (or the observation events included in the table) illustrated in FIG. **18** and flowcharts (or what order the processes regarding the observation events are carried out) illustrated in FIGS. **11** and **15**. Alternatively, the knowledge information may include item specified as know-how the operator or the cause event.

Such knowledge information can be input by the operator in the O&M system **100**. The item and event in accordance with the intention of the operator can be registered in the knowledge DB **140**. Accordingly, for example, the table illustrated in FIG. **18** and the flowcharts illustrated in FIGS. **11** and **15** can be registered in the knowledge DB **140**. The knowledge DB **140** is exemplified by the table illustrated in FIG. **18** and the flowcharts illustrated in FIGS. **11** and **15**, for example.

Next, the knowledge information reception process unit **152** receives the knowledge information via the operator IF process unit **150** and stores the knowledge information in the knowledge information DB **153** (S**126**).

Next, the knowledge renewal process unit **144** reads out the knowledge information from the knowledge information DB **153** classifies, for example, the knowledge information in units of apparatuses or devices, and stores the knowledge information in the knowledge DB **140** (S**127** to S**129**). In this case, the knowledge renewal process unit **144** reads out the observation event to be incorporated as new knowledge, which is the observation item, the observation data, and so on, from the process subject observation event DB **127** and stores the observation event to be incorporated, in the knowledge DB **140**, thereby renewing the observation event as new knowledge, for example.

Next, the estimating process of the cause event (S**130** to S**132**) will be described. The cause determining process unit **132** reads out the observation event from the change state event DB **128** and estimates the cause event based on the knowledge DB **140** (S**130** and S**131**). For example, the estimating process according to the table described in the section <5.1 Example of estimating process of cause event in tabular format> may be applied for the estimation of the cause event, or the estimating process according to the flowchart described in the section <5.2 Example of estimating process of cause event in decision format> may be applied for the estimation of the cause event. The detailed description of the estimating process has already been made, and the description is omitted herein. The cause determining process unit **132** stores the estimated cause event in the state event change cause DB **134** (S**132**).

Next, the cause communication process unit **133** outputs the cause event read out from the state event change cause DB **134** to the monitor **186** via the operator-or-external-output-apparatus interface unit **169**, thereby notifying the operator operating the O&M system **100** of the cause event (S**133** and S**136**).

In addition, the cause communication process unit **133** may store the cause event being notified to the operator in the notice log DB **135** (S**135**).

Next, the registering process of the operations of the operator (S**140** to S**147**) will be described. The operator IF process unit **150** receives the operations carried by the operator (S**140**). The operations represent what cope the operator has provided for the cause event, for example. For example, in the example of FIG. **21**, when "Admission threshold value is raised" as the cope is provided, the input command indicating that this cope is provided represents the operation. For example, the operation also represents the history of several manipulations in the course of input command, and so on.

Next, the operation history reception process unit **170** receives the operation by the operator via the operator IF process unit **150** and stores the operation in the operation history DB **171** as operation history (S**141**).

Next, the operation history analyzing process unit **172** extracts the operation history regarding the observation event to be processed from the operation history stored in the operation history DB **171** and stores the extraction result in the history analyzing DB **173** (S**143**), for example. Or, for example, the operation history analyzing process unit **172** may be configured to store the operation history, which is stored in the operation history DB **171**, in the history analyzing DB **173**.

The cause analyzing process unit **168** analyzes element to be reflected or utilized as the knowledge, with respect to the cause event stored in the state event change cause DB **134**, and stores the analysis result in the knowledge DB **140** (S**145** to S**147**). For example, the cause analyzing process unit **168** performs the register processes regarding "what cause event to estimate with respect to the observation event to be obtained", and "what operation to carry out with respect to the cause event to be estimated", in the knowledge DB **140**. Accordingly, the cause analyzing process unit **168** reads out the observation event from the process subject observation event DB **127** (S**145**), reads out the operation history from the history analyzing DB **173** (S**144**), and reads out the cause event from the state event change cause DB **134** (S**146**). And, the cause analyzing process unit **168** correlates and stores the observation event, the operation history, and the cause event in the knowledge DB **140** (S**147**).

<Narrowing Process for Observation Event>

Next, the narrowing process for the observation events will be described. The narrowing process for the observation events is a process of determining the observation event to be observed from the plurality of observation events, for example. For example, the narrowing process of the observation event makes it easy to identify the cause event and refine the cause event, and further makes it possible to facilitate the extracting process of the observation event or the entire processes.

In FIG. **4**, for example, the knowledge registering process unit **142** performs the narrowing process, determines the observation event, and outputs the determination results to the observation event extracting unit **121**, which allows the observation event extracting unit **121** to actually extract the observation event to be observed.

In FIG. **24**, for example, the observation event determined by the knowledge registering process unit **142** is input to the observation event extracting process unit **123** or the process subject observation event extracting process unit **124**, thereby extracting the observation event corresponding to the observed observation event, out of the collected observation events.

The estimating process of the cause event is considered as a process of extracting the corresponding cause event out of the cause events registered in the knowledge DB **140** with respect to the collected observation events (for example, FIG. **18**), for example. That is, as illustrated in FIG. **6**, it is conceivable that the estimating process of the cause event is a way to obtain a conditional probability P (X|Y) that any one of the cause events X={x1, x2 . . . xj} is selected with respect to the observation events Yj={y1, y2, . . . yj}.

FIGS. **26**A to **26**C represent the probability of the cause event in a case where the observation events H**1** to H**3** individually (independently) occur (or arise), for example.

For example, the observation event H**1** is the observation event regarding the attribute of "traffic". The observation event included in the observation event H**1** is exemplified by the observation events ("self cell traffic" is "high", and "another cell traffic" is "low", and so on) with respect to the items such as "self cell traffic" or "another cell traffic", for example. In addition, for example, the observation event H**2** is the observation event regarding the attribute of "radio resource". The observation event H**3** is the observation event regarding the attribute of "connection".

The O&M system **100** can estimate the cause event based on the plurality of observation events and based on the single observation event.

Herein, for example, in the system design regarding the mobile communication system, it is assumed that the observation events H1 to H3 respectively are attributed to two cause events C**1** and C**2**, and the probability of being attributing to the cause event C**1** and the probability of being attributing to the cause event C**2** have been estimated with respect to the respective observation events H**1** to H**3**.

Regarding the observation event H**1**, it is assumed that the estimation is made such that the probability of being attributing to the cause event C**1** is "3/4", and the probability of being attributing to the cause event C**2** is "1/4" (see, for example, FIG. **26**A). Regarding the observation event H**2**, it is assumed that the estimation is made such that the probability of being attributing to the cause event C**1** is "1/2", and the probability of being attributing to the cause event C**2** is "1/2". Further, regarding the observation event H**3**, it is assumed that the estimation is made such that the probability of being attributing to the cause event C**1** is "1/3", and the probability of being attributing to the cause event C**2** is "2/3".

Next, it is assumed that the observation events H**1** to H**3** occur with a uniform probability as an initial condition when the observation events H**1** to H**3** simultaneously occur (or arise). That is, the formula (1) represents as follows.

$$P(H1)=P(H2)=P(H3)=1/3 \quad (1)$$

In this case, when it is assumed that the observation events H**1** to H**3** simultaneously occur, and the cause event C**1** is estimated, the conditional probabilities P (H**1**|C**1**), P (H**2**|C**1**), and P (H**3**|C**1**) of being attributed to the cause event C with respect to the respective observation events H**1** to H**3** are respectively obtained as follows.

$$P(H1|C1)=\{(1/3)\times(3/4)\}/\{[1/3\times(3/4)]+[(1/3)\times(1/2)]+[(1/3)\times(1/3)]\}=9/19=0.47 \quad (2)$$

$$P(H2|C1)=\{(1/3)\times(1/2)\}/\{[(1/3)\times(1/2)]+[(1/3)\times(1/2)]+[(1/3)\times(1/3)]\}=6/19=0.32 \quad (3)$$

$$P(H3|C1)=\{(1/3)\times(1/3)\}/\{[(1/3)\times(3/4)]+[(1/3)\times(1/2)]+[(1/3)\times(1/3)]\}=4/19=0.21 \quad (4)$$

It is noted that the conditional probability P (H|C) may be referred to as the degree W of involvement in the cause event C with respect to the observation event H, for example.

According to the formulas (2) to (4), the observation events H**1** to H**3** simultaneously occur. When the simultaneous occurrence of the observation events H**1** to H**3** is attributed to the cause event C**1**, the observation event H**1**, out of the observation events H**1** to H**3**, can be deemed to be the most probable observation event (or event having the highest degree W of involvement). Accordingly, the O&M system **100** can determine that an attention is paid to the observation event H**1**, out of the observation events H**1** to H**3**.

For example, the knowledge DB **140** holds initial conditions (for example, formula (1)) and the probabilities of being attributed to the cause events C**1** and C**2** with respect to the observation events H**1** to H**3** (for example, the probabilities illustrated in FIGS. **26**A to **26**C). In addition, the knowledge registering process unit **142** reads out these values from the knowledge DB **140** and calculates the formulas (2) to (4) to be executed.

After that, the operation of the O&M system **100** is started, and when the O&M system **100** observes the simultaneous occurrence of the observation events H**1** to H**3**, the knowledge registering process unit **142** calculates the conditional probability (or the degree W of involvement) as follows.

$$P(H1|C1)=\{(9/19)\times(3/4)\}/\{[(9/19)\times(3/4)]+[(6/19)\times(1/2)]+[(4/19)\times(1/3)]\}=81/133=0.61 \quad (5)$$

$$P(H2|C1)=36/133=0.27 \quad (6)$$

$$P(H3|C1)=16/133=0.12 \quad (7)$$

FIG. **27** illustrates the values of the degree W of involvement in the cause event C**1** in the case where the O&M system **100** repeatedly observes the simultaneous occurrence of the observation events H**1** to H**3** (or the simultaneous occurrence of the observation events H**1** to H**3** is repeated). In FIG. **27**, the degree W of involvement based on "initial (setting) conditions" is represented as the formula (1). In FIG. **27**, the degree W of involvement on "first time" is represented as the formulas (2) to (4), and the degree W of involvement on "second time" is represented as the formulas (5) to (7). Further, in FIG. **27**, the degree W of involvement is represented in the case where it is assumed that the simultaneous occurrence of the observation events H**1** to H**3** is repeated, and as for any of the observation events H**1** to H**3**, the cause event C**1** is estimated.

As illustrated in FIG. **27**, as the number of times for the observation increases, the degree W of involvement in the cause event with respect to the observation event H**1** increases comparison with the other observation events H**2** and H**3**. For example, in the fifth time, the degree W of involvement in the cause event with respect to the observation event H**1** reaches a value of approximately 90%. In this case, the O&M system **100** can determine that the observation event H**1** is a subject to be observed. Here, even when the number of times for the observation is one time (for example, "second time" in FIG. **27**), the O&M system **100** can determine that the observation event H**1** is a subject to be observed, based on the formulas (5) to (7).

Thus, the O&M system **100** observes the observation event in time series. For example, when the observation events H1 to H**3** simultaneously occur, the O&M system **100** can determine what observation event to select as the subject to be observed, based on the degree W of involvement. For example, the O&M system **100** can determine that the observation event H1 having the highest degree W of involvement is considered as the subject to be observed. In this case, the O&M system **100** can estimate that the probability of being attributed to the cause event C**1** is high, compared with other cause event.

The degree W of involvement can be obtained as follows, regarding the case where it is assumed that the estimation is made such that the simultaneous occurrence is attributed to the cause event C**2**, based on the design condition and after-the-event analysis when the observation events H**1** to H**3** simultaneously occur.

$$P(H1|C2)=\{(1/3)\times(1/4)\}\times\{[(1/3)\times(1/4)]+[(1/3)\times(1/2)]+[(1/3)\times(2/3)]\}=3/17=0.18 \quad (8)$$

$$P(H2|C2)=\{(1/3)\times(2/3)\}\times\{[(1/3)\times(1/4)]+[(1/3)\times(1/2)]+[(1/3)\times(2/3)]\}=7/17=0.35 \quad (9)$$

$$P(H3|C2)=\{(1/3)\times(2/3)\}\times\{[(1/3)\times(1/4)]+[(1/3)\times(1/2)]+[(1/3)\times(2/3)]=8/17=0.47 \quad (10)$$

In this case, the observation event H**3** is higher in the degree W of involvement than the other observation events H**1** and H**2**, so that the O&M system **100** can determine that the observation event H**3** is the subject to be observed.

FIG. **28** is a flowchart illustrating the example of the operation of the narrowing process in the O&M system **100**. In FIG. **28**, the operation described above is included in the example of operation in FIG. **28**. The operation illustrated in FIG. **28** is carried out in the knowledge registering process unit **142**, and may be carried out in the observation event extracting unit **121**, other than the knowledge registering process unit **142**, for example.

As the initial condition, the knowledge DB **140** stores an initial degree W of involvement and the observation event based on each attribute classification indicating what observation event and attribute to correlate with each other (S**170**).

The initial degree W of involvement represents the degree W of involvement that can be obtained through the observation of the observation event of "first time", for example. For example, in the example described above, the initial degree W of involvement is represented by the conditional probability obtained by the formulas (2) to (4).

The observation event based on the attribute classification is represented by the observation events H**1** to H**3** described above, for example. The knowledge DB **140** stores the observation events based on the attribute classification (for example, H**1** and H**2**), for each of the attribute classifications, and the item of the observation event, which are included in the observation events based on the attribute classification (for example, "self cell traffic"), for example. The observation event based on the attribute classification registered in the knowledge DB **140** is registered in the knowledge DB **140** when the O&M system **100** is configured, in consideration of design conditions in the course of designing of the system, for example.

In the description below, in order to distinguish the observation events H**1** to H**3** with each observation event included in the observation events H**1** to H**3**, for example, there is a case where the former (observation events H**1** to H**3**) is referred to as "observation events based on the same attribute classification" or "observation events based on the attribute classification", and the latter (observation event included in the observation events H**1** to H**3**) is merely referred to as "observation event". For example, the number of observation events included in the observation event H**1** based on the same attribute classification may be single or plural.

On the other hand, the initialized degree W of involvement and the observation events based on the attribute classification can appropriately be changed or added in the O&M system **100** (S**171**).

The O&M system **100** can start the process on the assumption that the initialization is performed (S**150**).

When the O&M system **100** starts the process, the O&M system **100** extracts the observation event based the same attribute classification simultaneously occurring (S**151**).

For example, the knowledge DB **140** stores a plurality of observation events based on the same attribute classification and a flag indicating the observation events based on the same attribute classification simultaneously occurring. The knowledge registering process unit **142** reads out the observation events based on the same attribute classification and including a common flag, from the knowledge DB **140** and can extract the observation events H**1** to H**3** that are based on the same attribute classification and that simultaneously occur.

Next, the O&M system **100** determines the attribute classification of the observation events that simultaneously occur (S**152**) and compiles the observation events based on the same attribute classification that simultaneously occur (S**153**). For example, the knowledge registering process unit **142** determines whether there are other observation events that are based on the same attribute classification and that include the common flag or not. When there are other observation events, the knowledge registering process unit **142** allows the other observation events based on the same attribute classification to be included in the attribute indicated by the common flag. For example, the knowledge registering process unit **142** stores the observation events based on the same attribute classification after the compilation in the knowledge DB **140**.

Next, the O&M system **100** performs the processes S**154** to S**155** and S**160** for each of the observation event that is based on the same attribute classification and that simultaneously occur. For example, the O&M system **100** carries out the processes S**154** to S**155** and S**160** for each of the observation events H**1** to H**3** based on the same attribute classification.

That is, the O&M system **100** extracts the degree W (old) of involvement in the cause event corresponding to the observation event based on the same attribute classification (S**154**). For example, the degree W of involvement for each flag is stored in the knowledge DB **140**. The knowledge registering process unit **142** reads out the degree W of involvement regarding a certain flag from the knowledge DB **140** so as to extract the degree W (old) of involvement. For example, the knowledge registering process unit **142** reads out a value "9/19" in the formula (2) with regard to the observation event H**1** as the degree (old) of involvement.

Next, the O&M system **100** determines whether the estimation (determination) of the cause event can be made based on the knowledge DB **140** or not (S**155**).

For example, there is a case where the cause event can affirmatively be determined with respect to the observation event based on a certain attribute classification. When the above-mentioned case is applied (S**155**, YES), the knowledge registering process unit **142** can determine the cause event, which is affirmatively determinable as a conclusive cause event (S**156**). As a determining method, for example, the knowledge registering process unit **142** accesses the knowledge DB **140**, so that the determination can be made based on whether only one cause event with respect to the observation event based on the certain attribute classification is stored in the knowledge DB **140**.

On the other hand, when the estimation of the cause event is not made based on the knowledge DB **140** (S**155**, NO), that is, when the O&M system **100** determines that the estimation of the cause event needs the analysis of the observation event, the O&M system **100** analyzes the observation event (S**160**).

For example, when the knowledge registering process unit **142** obtains the observation event based on a certain attribute classification in which the degree W of involvement converges, according to the process of S**162** at a subsequent stage (S**162**, YES), such an observation event based on the certain attribute classification can be deemed as the subject to be observed. Accordingly, the knowledge registering process unit **142** confirms whether the observation event based on the certain attribute classification is obtained or not, thereby analyzing the present process, for example. It is noted that the detail of the process of S**162** is described below.

When the O&M system **100** can estimate the cause event based on the knowledge DB **140** (S**155**, YES), or when the O&M system **100** obtains the observation event based on the attribute classification, in which the degree W of involvement converges (S**160**), the O&M system **100** determines the conclusive cause event (S**156**).

For example, when the process goes to YES in S**155**, the knowledge registering process unit **142** reads out the cause event from the knowledge DB **140** and outputs the cause event to the cause event determining process unit **131**. In this case, the cause event determining process unit **131** outputs the cause event to the monitor **186** so as to display the cause event (S**157**).

In addition, the O&M system **100** ends a series of processes (S**158**).

On the other hand, for example, when the O&M system **100** does not obtain the observation event based on the attribute classification in which the degree W of involvement to be converged (S**160**), the O&M system **100** newly calculates a degree W (new) of involvement in the cause event corresponding to the observation event based on the same attribute classification (S**161**).

For example, when the observation event extracting process unit **123** obtains the observation event based on the attribute classification of the next circle, the observation event extracting process unit **123** outputs the observation event to the knowledge registering process unit **142**, and the knowledge registering process unit **142** obtains a new degree W (New) of involvement with respect to the obtained observation event based on the attribute classification of the next circle. For example, the knowledge registering process unit **142** calculates each value of the formulas (5) to (7) as the degree W (New) of involvement.

Next, the O&M system **100** determines whether W (old) <W (new) is satisfied or not (S**162**). That is, the O&M system **100** determines whether the degree W of involvement converges or not.

For example, a value "81/133" in the formula (5) is higher than a value "9/19" in the formula (2), which meets W (old) <W (new). In addition, a value "36/133" in the formula (6) is lower than a value "6/19" in the formula (3), which fails to meet W (old)<W (new).

For example, when any one of the plurality of the observation events H**1** to H**3** that are based on the same attribute classification and that simultaneously occur meets W (old) <W (new) (S**162**, YES), the knowledge registering process unit **142** determines that the degree W of involvement converges. In addition, the plurality of the observation events H**1** to H**3** that are based on the same attribute classification and that simultaneously occur all fail to meet W (old)<W (new) (S**162**, NO), the knowledge registering process unit **142** determines that the degree W of involvement does not converge.

When the O&M system **100** determines that the degree W of involvement converges (S**162**, YES), the O&M system **100** deems the observation events based on the same attribute classification as the observation event for the next time onward (S**163**).

For example, the O&M system **100** selects the observation event H**1** based on the same attribute classification, in which the degree W of involvement converges, as the subject to be observed, out of the plurality of the observation events H**1** to H**3** that are based on the same attribute classification and that simultaneously occur. For example, based on this selection, the O&M system **100** narrows down the plurality of the observation events H**1** to H**3** that are based on the same attribute classification and that simultaneously occur, into the observation event H**1** based on the same attribute classification, which is the subject to be observed, thereby the observation can be performed.

Accordingly, in the condition where hundreds and thousands of observation events are observed, the O&M system **100** does not estimate the cause event based on all the observation events that is observed, but estimates the cause event based on the observation event regarding the narrowed attribute classification (for example, the observation event H**1** based on the same attribute classification). Consequently, the O&M system **100** can estimate or determine the cause event from a huge mass of observation events. The O&M system **100** estimates the cause event based on the observation event regarding the narrowed attribute classification, so that the O&M system **100** can refine the observation event to be observed and facilitate the processing speed, compared with the case where the cause event is estimated based on all the observation events.

Returning to FIG. **28**, subsequently, the O&M system **100** stores the narrowed observation event and the degree W (new) of involvement in the knowledge DB **140** (S**164**). For example, when the degree W (new) of involvement stored in the knowledge DB **140** is read out by the knowledge registering process unit **142**, the degree W (new) of involvement is turned into the degree W (old) of involvement, and the process of S**154** is carried out.

On the other hand, when the degree W of involvement does not converge (S**162**, NO), the O&M system **100** determines whether the observation events based on the same attribute classification are overlapped with the observation events based on another attribute classification, or not (S**166**). This overlap will be described below.

FIG. **29** illustrates an example of the observation event based on the same attribute classification. In the example of FIG. **29**, another attribute classification H**4** is illustrated in addition to the attribute classification H**1** to H**3**. The observation events #6 and #7 belong to both attribute classifications H**3** and H**4**. For example, when the attribute classifications H**3** is exemplified by "connection", and the attribute classifications H**4** is exemplified by "quality states", and the observation events #6 and #7 belong to both of the attribute classifications H**3** and H**4**. As described above, it is assumed that the correlation of the observation event with the attribute classification is stored in the knowledge DB **140**, for example, in the course of designing of the system.

In the process of S**166** in FIG. **28**, when the degree W of involvement does not converge, the O&M system **100** determines that there is a problem in the combination of the three attribute classification H**1** to H**3** and further determines whether the observation events of another attribute classification H**4** is added or not, for example. For example, the knowledge registering process unit **142** determines whether the observation events H**1** to H**3** based on the original attribute classification are overlapped with the observation event of another attribute classification H4 or not, thereby carrying out the process.

Returning to FIG. **28**, when the observation event based on the certain attribute classification do not be overlapped with the observation event based on another attribute classification (S**116**, NO), the O&M system **100** notifies the operator or the designer of the absence of the overlap (S**167**).

For example, the knowledge registering process unit **142** notifies the cause event determining process unit **131**, and so on of the content in which there is a problem in the combination of the observation event that simultaneously occur and constitute the three attribute classification H1 to H3, and the content is displayed on the monitor **186**, thereby notifying the operator or the designer of the content. Accordingly, for example, the O&M system **100** can urge the operator or the designer to reconsider the design condition, and so on. For example, the operator or the designer changes the attribute classifications with respect to the observation event that is based on the attribute classifications H1 to H3 and that simultaneously occur, and the observation event that is based on the attribute classification after the change are stored in the knowledge DB **140** (S**171**).

Next, a series of processes ends (S**168**).

On the other hand, when the observation event based on the same attribute classification is overlapped with the observation event based on another attribute classification (S**166**, YES), the O&M system **100** calculates the degree W (other) of involvement in the cause event with respect to the observation event based on another attribute classification (S**169**). For example, the knowledge registering process unit **142** calculates the degree W of involvement in the cause event (for example, cause events C**1** or C**2**) with respect to the observation event H**4** based on another attribute classification.

Next, the O&M system **100** determines whether W (other) >W (new) is satisfied (S**180**). That is, the O&M system **100** compares the highest degree W (new) of involvement, out of the respective degrees of involvement in the cause event C**1** with respect to the observation events H**1** to H3 based on the attribute classification, with the degree W (other) of involvement in the cause event C**1** with respect to the observation event H**4** based on another attribute classification, so as to perform the determination, for example.

When the degree W (other) of involvement in not higher than the degree W (new) of involvement (S**180**, NO), the degree W (other) of involvement in the cause event with respect to the observation event based on another attribute classification is lower than the degree W (new) of involvement that does not converged. In this case, even when the observation event based on another attribute classification is included in the observation event based on the certain attribute classification, the degree W (new) of involvement does not converge, so that the O&M system **100** notifies the manager or the designer of the content in which there is a problem in the combination of the observation events based on the attribute classification (S**167**).

On the other hand, when the degree W (other) of involvement in the cause event with respect to the observation event based on another attribute classification is higher than the degree W (new) of involvement in cause event with respect to the observation event based on the attribute classification (S**180**, YES), the O&M system **100** changes the attribute classification (S**181**).

For example, the knowledge registering process unit **142** changes the attribute classifications in a manner that the observation events H**3**, out of the observation events H**1** to H**3** based on the attribute classification, is replaced with the observation events H**4**, or in a manner that that the observation events H**4** is added to the observation events H1 to H**3**, which is represented as the observation events H**1** to H**4** based on the attribute classification. It is noted that the knowledge registering process unit **142** calculates the degree of involvement in the cause event with respect to the observation events based on the attribute classification after the change and stores the degree of involvement in the knowledge DB **140**, for example.

Next, the O&M system **100** stores the attribute classification after the change in the knowledge DB **140** (S**182**). Henceforth, the O&M system **100** repeats the process (for example, S**154**) of extracting the degree W of involvement in the cause event with respect to the observation events based on the attribute classification after the change, from the knowledge DB **140**.

That is, the O&M system **100** stores the calculated degree W (other) of involvement in the knowledge DB **140** (S**182**), for example. In addition, the O&M system **100** reads out the values regarding the formula (1) and the formulas (2) to (4) with respect to the observation events based on the attribute classification after the change, from the knowledge DB **140** and calculates the degree W of involvement (formulas (5) to (7) and formulas (8) to (10)) (S**161**). In addition, the O&M system **100** calculates the degree W (new) of involvement (S**162**). When the calculated degree W (new) of involvement converges (S**162**, YES), the O&M system **100** narrows down the observation data, with respect to the observation events based on the attribute classification (S**163**), thereby estimating the cause event.

Thus, in the narrowing process, when the degree W of involvement in the cause event with respect to the observation events based on the attribute classification does not converge (S**162**, NO), the attribute classification is changed. Therefore, the degree W of involvement, which is newly calculated, is caused to converge. Accordingly, as the number of times for the observation is increased, the convergence of the degree W of involvement with respect to a certain observation event is increased (for example, H1 in FIG. **27**). Consequently, the O&M system **100** can narrows down the observation events based on the attribute classification, which is the subject to be observed.

<Display Example of Monitor Screen>

Lastly, an example of screen display regarding the observation events and coping method will be described. FIGS. **30** to **34** are diagrams illustrating the examples of such a screen display.

FIG. **30** illustrates the example of the display screen in a case where the extracted observation data is displayed on the monitor **186**. As illustrated in FIG. **30**, the date and time when the observation event is observed at the base station is displayed for every observation event. The base station can measure the date and time when the observation event is observed, along with the observation event, and the base station can transmit the observation event and the date and time to the O&M system **100**. The observation event receiving process unit **111** can obtain the observation event in time series, or can perform the process of putting the received observation event in the order of time series.

FIG. **31** illustrates the example of the screen display representing count value of the observation event included in each group for the grouped observation event. FIG. **31** illustrates the example in which the observation event observed at a certain base station is grouped into three group. For example, each group 1 to 3 represents the observation event based on the same attribute classification.

In addition, in the example of the screen display in FIG. **31**, for example, the count value of the observation event included in each of the groups is represented in time series. Alternatively, for example, the count value of the observation event observed at an adjacent cell (or base station) at the same time is represented. The O&M system **100** can grasp the number of times for the observation with respect to the observation event included in each of the groups, based on the count value, for example.

FIG. **32** illustrates the example of the screen display representing the degree of involvement in the cause event in a graphic format. For example, FIG. **32** corresponds to FIG. **27**. The degree W (new) of involvement that is calculated at a certain timing in the knowledge registering process unit **142** (for example, S**161** of FIG. **28**) is illustrated in a graph. For example, FIG. **32** represents a state where the degree W of involvement in each cause event is illustrated in the line graph. According to this screen display, the operator, and so on can recognize what value the degree W of involvement in the cause event is, or compare the present cause event with other cause event.

FIG. **33** illustrates the example of the screen display representing the degree of involvement in a tree-based form (tree form). For example, FIG. **33** illustrates the example of the screen display in a case where the relation of the plurality of cause events is represented in the tree-based form or the relation of the cause event estimated at a certain timing (or circle) and the cause event estimated prior to the certain timing is represented in the tree-based form when the O&M system **100** estimates the plurality of cause events. For example, this tree-based form is stored in the knowledge DB **140**. For example, the O&M system **100** can notify the operator of the relation of the cause event by the screen display via monitor **186**.

FIG. **34** illustrates the example of the screen display representing the cause event and coping methods corresponding to the cause event. For example, FIG. **34** illustrates the example of the screen display displayed on the monitor **186** of the O&M system **100** or a monitor of another apparatus via the operator-or-external-output-apparatus interface unit **169** (FIG. **25**).

As illustrated in FIG. **34**, the observation event and the corresponding cause event are respectively displayed in item columns **1861** and **1862** on the screen. Further, the coping method corresponding to the cause event is displayed in the item column **1863**. For example, "level **1**" is displayed as the most probable cause event, and "level **8**" is displayed as the least probable cause event. As described in FIG. **34**, for example, the number of coping methods may be plural or single.

These coping methods are stored in the knowledge DB **140**, for example. For example, the O&M system **100** reads out the coping method corresponding to the estimated cause event, thereby displaying the coping method along with the estimated cause event on the monitor **186**.

For example, the cause event is displayed based on the screen display illustrated in FIG. **34**, which allows the O&M system **100** to appropriately notify the operator or surveillant of the change or displacement in terms of operational state. Further, for example, the coping method is displayed based on such a screen display described above, so that the O&M system **100** can support the operator or the surveillant in decision-making.

Other Embodiments

Next, other embodiments will be described.

FIG. **35** is a diagram illustrating an example of another configuration of the O&M system. The O&M system includes the monitor **186**, an NWIF **190**, an operator IF **191**, a Central Processing Unit (CPU) **192**, a Random Access Memory (ROM) **193**, and a Read-only Memory (RAM) **194**. The CPU **192**, the ROM **193**, and the RAM **194** are connected with each other via a bus **195**.

The NWIF **190** corresponds to the NWIF process unit **110** in the second embodiment (for example, FIG. **3**), for example. The operator IF **191** corresponds to the operator IF process unit **150** in the second embodiment, for example. The CPU **192** corresponds to the observation event process unit **120** and the cause event determining unit **130** in the second embodiment, for example. Further, the RAM **194** corresponds to the knowledge DB **140** in the second embodiment, for example.

The CPU **192** corresponds to the observation event extracting unit **121**, the observation event analyzing process unit **122**, the cause event determining process unit **131**, the knowledge addition/correction process unit **141**, the knowledge registering process unit **142**, the associated information receiving process unit **160**, the statistical analysis process unit **180**, the cope history process unit **182**, and the display editing unit **184**, in the second embodiment (for example, FIG. **4**), for example.

Further, the CPU **192** corresponds to the operation environment analyzing process unit **163**, the knowledge information reception process unit **152**, the cause communication process unit **133**, and the operation history analyzing process unit **172**, in the second embodiment (for example, FIGS. **24** and **25**), for example.

Further, the RAM **194** corresponds to the observation event DB **113**, the process subject observation event DB **127**, the change state event DB **128**, the state event change cause DB **134**, the notice log DB **135**, the knowledge information DB **153**, the operation information DB **162**, the operation environment condition DB **164**, the extract observation event DB (t−1 time part) **165**, the extract observation event DB (t-time part) **167**, the operation history DB **171**, and the history analyzing DB **173**, in the second embodiment, for example.

The CPU **192** reads out a program stored in the ROM **193** via the bus **193**, loads the program in the RAM **194**, and executes the loaded program, which achieves the function of each of the corresponding process units described above. At that time, the CPU **192** accesses the RAM **194** to store data, so that the data can be stored in and read out from the DBs including the knowledge DB **140**.

According to an aspect of the embodiments, the operation monitoring apparatus, the cause event estimating method for the operation monitoring apparatus, and the information communication network system can be provided in which the cause event can be estimated or determined from a huge mass of observation events.

According to another aspect of the embodiments, the operation monitoring apparatus, the cause event estimating method for the operation monitoring apparatus, and the information communication network system can be provided in which the change or displacement of operational states in the information communication network system can appropriately be notified to the operator or the surveillant.

Further, according to another aspect of the embodiments, the operation monitoring apparatus, the cause event estimating method for the operation monitoring apparatus, and the information communication network system can be provided in which the decision-making can be supported for the operator or the surveillant.

All examples and conditional language provided herein are intended for the pedagogical purposes of aiding the reader in understanding the invention and the concepts contributed by the inventor to further the art, and are not to be construed as limitations to such specifically recited examples and conditions, nor does the organization of such examples in the specification relate to a showing of the superiority and inferiority of the invention. Although one or more embodiments of the present invention have been described in detail, it should be understood that the various changes, substitutions, and alterations could be made hereto without departing from the spirit and scope of the invention.

What is claimed is:

1. An operation monitoring apparatus for estimating a cause by which a first and second observation data observed by a monitored apparatus are obtained, the operation monitoring apparatus comprising:

an observation event receiving process unit which receives the first and second observation data transmitted from the monitored apparatus;

an observation event extracting unit which extracts the first observation data, out of the first and second observation data, based on a first probability that the cause occurs with respect to the first and second observation data at time t−1, and a second probability that the cause occurs with respect to the first and second observation data at time t;

a cause event determining process unit which estimates the cause based on the extracted first observation data; and

a cause notifying process unit which outputs data indicating the estimated cause.

2. The operation monitoring apparatus according to claim **1**, wherein

the observation event extracting unit extracts the first observation data when the second probability is higher than the first probability, and

the observation event extracting unit changes attribute classification to which the first observation data belongs, and extracts the first observation data based on a third probability that the cause occurs with respect to the changed attribute classification, when the second probability is not higher than the first probability.

3. The operation monitoring apparatus according to claim **2**, wherein

the observation event extracting unit calculates the third probability that the cause occurs with respect to other attribute classification overlapping with the attribute classification to which the first observation data belongs, when the second probability is not higher than the first probability, and

the observation event extracting unit changes the attribute classification to which the first observation data belongs, to the other attribute classification, when the calculated third probability is higher than the second probability.

4. The operation monitoring apparatus according to claim **1**, wherein

the cause notifying process unit outputs data indicating a coping method corresponding to the estimated cause.

5. The operation monitoring apparatus according to claim **4**, wherein

the cause event determining process unit outputs data indicating the different coping method in accordance with the value of the first observation data received by the observation event receiving process unit.

6. The operation monitoring apparatus according to claim **1**, wherein

the observation event extracting unit inputs operation associated information including event information regarding an event and cell information regarding a radio base station apparatus, and extracts the first observation data based on the operation associated information.

7. The operation monitoring apparatus according to claim **1**, further comprising a memory stores data indicating the cause with respect to the first observation data, wherein

the cause event determining process unit reads out the data indicating the cause with respect to the extracted first observation data from the memory and estimate the cause.

8. The operation monitoring apparatus according to claim **7**, wherein

the memory includes a table in which data indicating one or a plurality of causes in accordance with value of the first observation data is stored, and

the cause event determining process unit reads out from the table the data indicating the cause in accordance with the value of the first observation data received by the observation event receiving process unit.

9. The operation monitoring apparatus according to claim **1**, further comprising:

a memory; and

a cause analyzing process unit stores in the memory data indicating the estimated cause and data indicating coping method performed by an operator with respect to the estimated cause, wherein

the cause notifying process unit reads out from the memory the data indicating the coping method corresponding to the cause and outputs the data indicating the coping method, when the cause event determining process unit estimates the cause.

10. The operation monitoring apparatus according to claim **1**, wherein

the first observation data is data of one or a plurality of observation data belonging to a first attribute classification, and the second observation data is data of one or a plurality of observation data belonging to a second attribute classification.

11. The operation monitoring apparatus according to claim **1**, wherein

probability that the cause occurs with respect to the first and second observation data includes a first conditional probability indicating a conditional probability of the cause with respect to the first observation data and a second conditional probability indicating the conditional probability of the cause with respect to the second observation data.

12. An estimating method of cause event in an operation monitoring apparatus for estimating cause by which a first and second observation data observed by a monitored apparatus are obtained, the method comprising:

receiving the first and second observation data transmitted from the monitored apparatus, by an observation event reception process unit;

extracting the first observation data, out of the first and second observation data, based on a first probability that the cause occurs with respect to the first and second observation data at time t−1, and a second probability that the cause occurs with respect to the first and second observation data at time t, by an observation event extracting unit;

estimating the cause based on the extracted first observation data, by a cause event determining process unit; and

outputting data indicating the estimated cause, by a cause notifying process unit.

13. An information communication network system comprising:

a monitored apparatus; and

an operation monitoring apparatus which estimate cause by which a first and second observation data observed by the monitored apparatus are obtained, wherein

the operation monitoring apparatus including:

an observation event receiving process unit receives the first and second observation data transmitted from the monitored apparatus;

an observation event extracting unit which extracts the first observation data, out of the first and second observation data, based on a first probability that the cause occurs with respect to the first and second observation data at time t−1, and a second probability that the cause occurs with respect to the first and second observation data at time t;

a cause event determining process unit which estimates the cause based on the extracted first observation data; and

a cause notifying process unit which outputs data indicating the estimated cause.

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